

Metallurgical & Chemical Engineering

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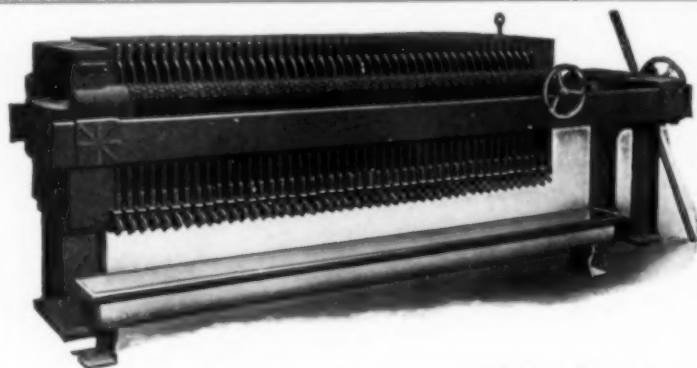
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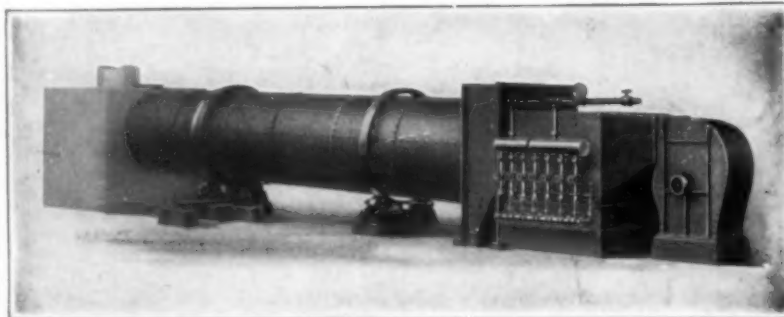
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Metallurgical and Chemical Engineering

A Consolidation of
ELECTROCHEMICAL AND METALLURGICAL INDUSTRY and IRON AND STEEL MAGAZINE

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Niagara Power Crisis

CANADA:

"Drink waters out of thine own cistern, and running waters out of thine own well.

"Let thy fountain be dispersed abroad, and rivers of waters in the street.

"Let them be only thine own, and not strangers' with thee."—*Proverbs*, V. 15-17.

NIAGARA FALLS, NEW YORK:

"Then I said, I am cut off."—*Lamentations*, III. 54.

"Give us water."—*Exodus*, XVII, 2.

THE SECRETARY OF WAR:

"Hear now, ye rebels; must we fetch you water out of this rock?"—*Numbers*, XX. 10.

"But he hanged the chief baker."—*Genesis* XL. 22.

Chemistry Should be Represented on the Tariff Commission

After thirty troublesome years of "tariff tinkering" without satisfying anybody, Congress in the last session created a Tariff Commission to put the discussion of the whole tariff problem on a sound scientific basis. To enable the commission to fulfill its mission, two things are all important. First, the commission must not be in politics. Congress has provided for this, as far as possible, by making the commission non-partisan or bi-partisan in personnel. Second, the personnel of the commission must be so chosen that it is in harmony and synchronism with the spirit of the present industrial evolution. It is left to President Wilson to solve this more difficult problem.

While the chief duty of the commission will be to gather information in a wide field, rather than to suggest legislation, yet its reports will be in fact, if not in form, recommendations of legislation. But it would be disastrous if for this reason lawyers should be thought to be especially suitable for members of the Commission. The basis of law is in precedents; lawyers have professionally a backward vision. What is needed of the members of the Tariff Commission, is a first-hand personal knowledge of the industrial problems of to-day and a forward vision of the problems of to-morrow. To be more specific, if it is true (and who does doubt it?) that chemistry will form the keynote of the industrial to-morrow of this country, then chemistry should be properly represented on the Tariff Commission. One member at least of the commission should be a real chemist, not so much a man with the fullest knowledge of chemical facts, but a man capable of interpreting chemical facts correctly, a man in sympathy with the tendencies in chemistry—a man with a chemical vision.

The directors of the two leading chemical societies of this country—the American Chemical Society and the American Electrochemical Society—have properly taken a stand in this fundamentally important matter and have recommended Mr. Ellwood Hendrick of New York to President Wilson for a place on the commission. We are glad to say that we do not know any one in the chemical fraternity better fitted by temperament and training and specific ability to do justice to this peculiarly difficult and important position than Mr. Hendrick.

Iron Ore Prices

An annual event in the iron trade is the fixing of Lake Superior iron ore prices for the season. This time the event occurred Nov. 23, prices for 1917 being established at \$1.50 above those ruling for 1916. The event might perhaps be called "the annual gamble," seeing that as a rule the last of the ore bought is not used until about eighteen months after the transaction is consummated, and pig-iron prices have a habit of moving in more than one direction in a period of such duration. More often than not pig-iron prices decline after an ore advance, or advance after an ore decline, not because the change in ore price tends to produce such a result, but because it is the nature of pig iron to decline after it has advanced, and vice versa, while it is natural for the ore interests to advance their prices when pig iron has advanced, and to reduce them when pig iron has declined.

There have been times, as in 1913, when the coke and ore producers received the lion's share of the increase the merchant furnace had secured in pig iron, while there are other times, as in the case of the iron ore shipped in 1915, when the furnaceman received large advances for pig iron without having to divide with the ore producer. Thus the sale of ore represents a gamble in the case of both parties. The establishment of an ore mine in itself is a gamble, however. While at a given time the ore trade has certain conventions, as to how much overburden it would "pay" to remove in order to uncover a given body of ore, the course of the ore market from year to year may make the venture look extremely safe or extremely hazardous. In 1915, when prices were low, the price f.o.b. mine realized for Mesabi non-Bessemer ore ran about \$1.80 per ton; in 1917 about \$3.45 will be realized. While wages and supplies have greatly increased and royalties are higher in many instances, it seems safe to estimate that the profit in 1917 will be more than a dollar a ton, or the total profit that would be counted on to be realized for a period of several years in order to return the capital invested in stripping and equipment.

The merchant furnaceman is finding that the advances he has been obtaining on pig iron are not to be all clear profit by any means. It is only a year and a half ago that merchant furnaces in the Mahoning and Shenango valleys were selling pig iron at about \$12.50 per ton, but with advances in coke, ore and various supplies, and several successive ad-

vances in wages, the prospective cost is probably all of \$20 a ton.

Altogether the iron and steel business is an uncertain one. There is no way in which it can be "played safe." If a concern establishes itself with all its raw materials, so that it is not subject to the fluctuations of the market in purchasing supplies, it is hazarding its capital against lean years in which it will be unproductive. Another concern may invest a much smaller amount of capital, confining its business to one operation, buying ore and coke, for instance, and selling pig iron or buying sheet bars and selling sheets, and in the long run it may yield a larger return on its investment. Profits in the industry are only a matter of averages. All along the line profits are now abnormally high, but the amount that may be lost when the inevitable readjustment comes is purely a matter of conjecture. Any producer who does not lay aside a large part of his present earnings against such a contingency is taking a great risk.

Expensive Slums

In our last issue we wondered what would happen to all the profits that are being made, and in the end it looked more wholesome to us that the people be engaged in making a living than that there be great profits amassed. And yet, if it is good to be gaining a living and achieving an independence, why is it not good to have both? It would seem that it should be, but we are such odd sticks that logic is about the last thing that holds good with us. There are, however, a few things that we know without any philosophizing; for instance, that the production, by industries, of a group of millionaires, on the one hand, and the establishment of slums on the other, is not a good thing for the country. Welfare is not to be measured by sales or by profits unless there is a betterment all around. There is something wrong, radically wrong, about any industry or any works that causes slums to come into being or to be maintained. Something so wrong that it is time now, this minute, to get busy over the situation.

Slums constitute a social disease, a vicious, contagious disease, and there is no use in trying to dodge responsibility for them. Suppose we were masters of a school and scarlet fever were raging among the children of the town. We might say that we do not profess to know anything about the disease, we are not physicians, our business is teaching, and we insist upon the presence of every child that can come. We should then be responsible for the spread of the disease by our neglect. Now suppose we establish an industry and, of course, need labor. Labor is scarce, and we pay the market price, which is high. We may think that we are fulfilling our duties, completely and entirely, when we hand over the pay envelopes; but a moment's consideration will demonstrate how wrong this is. In bringing up children, a parent's duty is not done when he has bought clothing and food for them. There are other duties, and the parent is blamed if he does not look after them. Again, a man does not achieve either righteousness or good repute by living simply within

the law. If he would have standing he must do more than that. But these are personal affairs, and concerning them we can, if the public gets too curious, tell it to go to the Balkans. The way we order our lives is our own business. But as soon as we engage in industry we are quasi-public characters; our success or failure affects the whole neighborhood, and our judgments and conclusions become very far-reaching. The public has an actual interest in our works. If, as the result of our establishment, slums arise, either by our acts or through our neglect, we are blamed for it, and what is more, we can't get clear of the charge. We may say it is none of the public's business, but even that will not help us. The public says it is, and it can and will proceed to tax the very innerds out of us if we continue to offend.

So, let us suppose that we are starting an industry and are engaging men. When we do this we are doing far more than making simple, short-time contracts with them. We are inviting each man to come and make his living with us, to bring his wife and family and settle down near the works. More than likely the man will not bother about his obligations to us at all; he believes, no matter what we say, that we shall lay him off whenever work grows dull, and he is not likely to worry over any agreement he may have made with us if he sees a chance to better himself. Provided always he comes from the slums he is likely to make an agreement one week and break it the next, if he can see any advantage in it. The trouble here is that he is too far down in the scale of living to be a responsible person. Under the pinch of the poverty that starves we cannot ask for good manners, and under stress of hand-to-mouth living we are not even speaking current language among laborers if we discuss contract obligations. They pay rent in advance and cash for groceries and provisions, and they have no experience in the sequence of payment after a debt is incurred. They are engaged in a low order of living in an ill-smelling, sour, ugly, cold world. They live in slums. So long as they abide in this low estate there is no such thing as a "gentlemen's agreement" to be made with them. They're down and out, and are too low-lived to be held responsible. When they get to living under better conditions we can begin to expect or hope for them to keep their agreements, but until then it is unwise to ask it of them.

Of course, workers from the slums are easily handled in one respect—they are usually so poor and want work so badly that they will do anything they are told to do. They may be a wretched lot, but they are easily driven. When they begin to do better and feel better they may organize and make all sorts of demands, many of which are neither reasonable nor just. So trouble is avoided for the moment by keeping men down to the need of to-morrow's pay. If, however, this involves the maintenance of slums, the price is too high. While the employer is making profits the state is raising weeds.

One of our excuses for slums is likely to be that the persons living there are foreigners who can't speak English, who do not know any better and who can't

learn. This is true, some of them are feeble-minded. But not all of them, by any means. And those who are not feeble-minded, by living in slums and losing heart and cultivating the gospel of hate, which is poison, are not likely to become good citizens. Children that grow up there are under a very serious handicap, and they are far more likely than other children to become a burden upon the state. They furnish the great body of criminals. Slums do not make for that wholesome discontent that seeks betterment; they make for blind hatred that seeks only to destroy such system and order as we have.

There is a scarcity of food, both in Germany and in England, and provision is now made in both countries for its more equable distribution. The shortage of food is bad, but the discipline and improved methods of distribution may, in the end, be good. It surely will provide for improvement in distribution unless a great, destructive revolution follows the war. In this country we used to provide for the needs of the hands by means of company stores until the way the poor devils were gouged became a scandal and then the thing had to stop.

Now we are beginning to feel a scarcity of food over here, and prices are soaring 'way over the tops of wages. And we do not seem to be making much of any provision against it, so far as we are informed. We say we haven't the time to bother about such things, but neither have our men the time or the opportunity or in many cases the intelligence to look up cheaper supplies.

It seems no more than fair that employers should take this matter up without any fuss or boasting and furnish employees with coal and provisions at approximately cost price, with a view to making the wages they pay more nearly a living. We need not worry about the little slum grocer who charges a hundred per cent profit on some of his wares. The reason why such merchants in slums are in such great profusion is solely because they can overcharge. On the other hand, slum conditions cut down the efficiency of wages from 20 to 50 per cent, a condition that is aggravated in a rising foodstuff market.

The slum must go. It does more harm than the profits of an industry do good. It is so poisonous, so vicious, that the social surveyors will soon have slums catalogued and accorded to the industries from which they spring. There will be no getting out of responsibility for them by moving the works out into the lonesome valleys or into the crowded cities, for the man's job and where he works is about the first thing the industrial inquisitors ask. Slums seem to have grown out of industries, and it is the industries that must destroy them. If they are not destroyed the blame and the onus will rest upon industry. This is sure to happen, because it is not at all difficult to connect slums up with their causes, and these are, usually, merely faults of omission.

It is needful for industries that they be in good standing, and they cannot maintain good standing so long as they have slum attachments.

Readers' Views and Comments

Electrolytic Recovery of Lead from Brine Leaches

To the Editor of Metallurgical & Chemical Engineering

SIR:—In your issue of Oct. 1, 1916, page 410, a paper is published by Messrs. Sims and Ralston entitled, "The Electrolytic Recovery of Lead from Brine Leaches." It seems to the writer that some of the deductions of the paper are open to criticism.

The authors state that "because of the very high current densities used the multiple connections are out of the question, owing to the immense size of busbars that would be necessary." Do they appreciate that busbars up to 26 square inches of cross section, carrying a tank current of 20,000 amp. are in use to-day in a prominent copper precipitation plant? The tank current for multiple connection at a cathode current density of 40 amp. per square foot of surface, as proposed, figures out at only 14,400 amp., an amount of current not difficult to handle. Of course, the capital outlay for such busbars is heavy but the proposition is unsuited for organizations with small capital available and the others would be able to stand it.

I fail to see why such high current densities are emphasized, 40 to 60 amp. per square foot. In Fig. 3 of the article, fixed current density curves showing the relation between cathode efficiency and concentration of lead in the electrolyte are given. It will be seen that the curve for 20 amp. per square foot gives about the best average result for all variations of strength of lead solution. Its advantage becomes more marked as the solution becomes weaker. Yet the plan for a 10-ton operating plant calls for a 40-amp. density.

This brings me to another point. According to a comparative table given, the highest yield of lead per kilowatt-hour, 16.1 lb., comes at the neglected current density of 20 amp., and using a multiple system. Yet the scheme for an operating plant is laid out on the series system and with the idea of working toward a possible yield of only 5.9 lb. per kilowatt-hour. It would seem as though more attention might be focused on a 20-amp. density, a multiple system, and the figure of 16.1 lb. yield per kilowatt-hour, particularly as a new process is being considered which as outlined will work at the narrow margin of profit of only \$22 per ton of product.

The plan for a commercial tank calls for a screw conveyor in the bottom to push the loose sponge deposit out into a collector. Sponge deposit in electrolytic precipitation plants is the bane of existence to the operators. Working for a coherent deposit would seem more logical and this could doubtless be readily obtained at a lower current density. The trend of precipitation plants as used for copper and zinc is toward large aggregate units, say 100 to 500 tanks. The high equivalent of lead, about 3.26 that of copper and 3.17 that of zinc, enables the lead plant to be much more compact for equal tonnage. As it is safe to say that the most favorable results with lead will only be obtained when working on a large scale, it will be seen that even with the advantage just mentioned we run into a large number of tanks, perhaps 100 or more. What I am getting at is that mechanical difficulties are to be anticipated in attempting to keep so many screw conveyors properly at work during the greater part of the time and in large deep tanks where they are inaccessible. The screw conveyors would seem to be a weak point in the process, not to mention the air agitation, long since abandoned for similar work.

It would appear that much promise would lie in experiments along the lines of moderate current density; coherent deposits, to be obtained naturally or by the use of suitable addition agents; efficient circulation by a properly directed flow; tanks clear of all mechanical apparatus, i.e., as simple and fool-proof as possible; partial rather than complete electrolysis of the lead solution; a multiple system in preference to a series; a better yield per kilowatt-hour, which would come naturally from some of the preceding factors. The use of iron anodes appears excellent both in theory and practice and would doubtless go far toward solving what is usually one of the biggest problems in such processes.

Messrs. Sims and Ralston are doing pioneer work and personally the writer is confident that a future will develop for electrolytic precipitation of lead, just as zinc is rapidly progressing at present and occupying the attention of metallurgists as copper began to do several years ago.

Lexington, Mass.

MAURICE R. THOMPSON.

* * *

To the Editor of Metallurgical & Chemical Engineering

SIR:—We are grateful for the discussion by Mr. Maurice R. Thompson of our paper, which was presented at the September meeting of the American Electrochemical Society and which was published in the October 1 issue of METALLURGICAL AND CHEMICAL ENGINEERING, and thank Mr. Thompson for his helpful criticism of our work. The questions raised by him show that it would have been well for us to have explained more fully our ideas as to the proper design of a commercial cell for this kind of work.

We are fully aware of the advantages of the multiple form of connections as suggested by Mr. Thompson, but conditions other than those ordinarily met with in the electrolytic refining or hydroelectric extraction of copper and zinc, have to be considered. Our work at the Salt Lake station of the Bureau of Mines has to do with developing ways and means of treating low-grade and complex ores. Among the pressing problems are those of the treatment of small low-grade deposits of lead carbonate which are of a physical character such as to defy mechanical concentration. The brine leaching process outlined would allow of the extraction of the lead in a very simple and inexpensive leaching plant, but when it comes to the electrolytic precipitation of this lead we are confronted by the fact that generators of high ampere capacity and low voltage cost 200 to 300 per cent more than generators of more normal voltage, and lower amperes. In addition to the cost of generators there is the investment in large bus bars which, although allowing better efficiency, would make the installation costs prohibitive for a small plant designed for the treatment of a small deposit of ore. Where a very large deposit of ore is to be treated, a larger plant could be designed in which advantage could be taken of some of these rather expensive ways of improving electrical efficiency. High-efficiency electrolytic plants are usually not classed among low first-cost metallurgical ventures.

Then, too, it is to be remembered that in this particular work so much lead is obtained per kilowatt-hour of energy expended that the cost of power is very small compared to the other items. We would also call attention to the fact that this cost, even at the sacrifice of some efficiency, is only one-fourth of the cost of the iron

used or anodes. Under these circumstances the economy of power should not be the prime consideration in the design of the electrolytic plant for lead work, while it is all-important in copper and zinc work. A cheap high-voltage, low-amperage generator, with small bus bars and series connections, permits of the use of a cell that covers only a very small floor space. This means that a small and comparatively inexpensive precipitation plant can be built for the recovery of lead from brine leaches which we feel is the condition that must be met when treating such ores as are being studied in our work. The use of an electrolytic equipment costing twice or three times as much as the proposed plant, would cut the power costs in half and save \$1.70 on every ton of lead, or 17 cents on every ton of ore, as far as operating costs are concerned. This 17 cents might pay interest on the extra investment if the investment were justified by the size of the deposit being treated. At the best it would mean a small saving.

Taking up the question of sponge metal and the method of removing it from the tanks and handling it, we agree with Mr. Thompson that it would be much better to have a process giving solid deposits instead of sponge. However, in all of the voluminous literature on the deposition of lead we know of no process which has obtained solid reguline deposits from chloride solutions. Our excellent leaching agent unfortunately is a bad solution for electrolytic work. The only improvement over the production of true sponge which we could suggest was to use a slight acidity in the brine, under which, as stated, the sponge had the appearance of heavy crystals which built up and subsequently fell off of the cathode plates.

The disadvantages of a screw conveyor buried deep in the bottom of a cell are acknowledged by us but they are not what could be called serious—merely inconvenient. But if the solution does not allow of the formation of reguline deposits and we find that a semi-crystalline sponge can be formed with ease and handled with comparative ease, the question came up, "What is the use of trying to remedy something which is really hardly a disadvantage?" As stated in the paper we decided to seize the bull by the horns and make sponge metal, and thereby open up the use of a range of electrical conditions in the electrolytic work which was otherwise not possible.

Mr. Thompson also objects to the air stirring but with the high current densities which seemed allowable in this case, we found that no amount of natural circulation was sufficient. It is to be remembered that we are dealing with a highly conductive brine but that it is very dilute as far as lead is concerned, and intense stirring is necessary. Air stirring is one of the most efficient ways of turning over a solution.

We believe that this explains why all of the apparently objectionable things were done in this work. Mr. Thompson's discussion, however, is timely and seems to emphasize the fact that the problems involved in a hydro-electrometallurgy of lead are different from those which ordinarily confront the electrometallurgist.

Salt Lake City, Utah.

O. C. RALSTON.

Facts About Potash

To the Editor of Metallurgical & Chemical Engineering

SIR:—In your issue of Nov. 1, 1916, page 508, is an article on the "Development of Our Potash Industry," by F. M. de Beers, in which the following statement appears: "A brief review here of what we bought on the average per year from Germany may not be out of place. In round figures the following list shows approximately what we imported each year:

	Tons
Potassium muriate (80 per cent).....	250,000
Potassium sulphate (90 per cent).....	50,000
Manure salts (20-38 per cent).....	200,000
Kainit (12-15 per cent).....	500,000

Total 1,000,000

"Figuring all the potash as K₂O or potassium oxide would show about 360,000 tons of the oxide in the above importation. Our yearly supply of German potash cost us about \$20,000,000 before the war."

This statement is false in every particular. The real imports of actual potash (K₂O) from Germany for the past ten years, including all used in agriculture and in chemical industries, are as follows:

Year	Short tons K ₂ O
1904	117,444
1905	129,084
1906	155,974
1907	144,351
1908	136,057
1909	173,220
1910	279,780
1911	274,446
1912	253,678
1913	267,970
Average, ten years	193,200

It will be seen that the average yearly imports were only 53.6 per cent of what Mr. de Beers states they were, and the maximum in any year were only 77.8 per cent of his alleged average of 360,000 tons of K₂O. His statement of cost, \$20,000,000, is about 50 per cent above the actual cost c.i.f. American ports.

No industry keeps more accurate production statistics, or distributes them more willingly than the potash industry—they are available to anyone who asks for them. For the past seven years "potash baiting" has been a favorite pastime of sensationalists from the highest officials down to the humblest penny-a-liner. Heretofore this has been a source of innocent merriment to those connected with the potash industry. But it is hardly right to permit such misleading statements to stand without correction.

German Kali Works,
New York City.

H. A. HUSTON.

* * *

To the Editor of Metallurgical & Chemical Engineering

SIR:—Answering Dr. Huston's criticism, I must apologize if I offended the German Kali Works, as there was certainly no intention to do any harm as might appear from Dr. Huston's agitation. In the first place, I am pleased to note that no specific fault was found with the table itself which is, I would therefore understand, an average of our importations of recent years (1911-12-13). These are the years that interest us most as representing more nearly our present needs. In the second place this paper was not intended as a review of what we imported. The title indicates that I prepared the same by request and on the last day before I left Chicago to present it, I added the clause about our importation, thinking this would interest my audience, although I realized this might not be entirely correct, but would be sufficiently so for the purpose intended. The only ready reference I had this last day was a set of year books published by the American Fertilizer.

It is evident that some of the percentages were a little wrong or that the average K₂O content was lower than I figured, but no harm was intended and I fail to see where any was done. If the actual K₂O imported was only 75 per cent of what I read as being approximate figures, it is reasonable to suppose that by this

time, but for the war, my estimate would be nearly correct.

The value is proportionally wrong also, but whether the amount is \$16,000,000 or \$20,000,000 has little bearing on the subject matter of my paper, which was intended to show what *we are doing* and what we can hope for.

I trust Dr. Huston does not imagine that I would presume to write a paper on the German potash industry or any of its branches. His words are rather harsh and because of this they make me wonder if anyone is afraid our little infant industry might develop too rapidly.

I tried in my paper to make it clear that only a few of our present sources can be commercially successful during normal times and that our next year's production is only possible because of the very high prices at present. It is certainly fortunate for me that Dr. Huston did not begin his table back about 1890, for that would make my rough approximations look still worse.

Chicago, Ill.

F. M. DE BEERS.

Guayule and Industrial Preparedness

To the Editor of Metallurgical & Chemical Engineering

SIR:—I have read Mr. King's article on Guayule and Industrial Preparedness with a great deal of interest and I wish to say that this is a most important problem for our country. Three years of war conditions have demonstrated that we are impotent so far as rubber supplies are concerned, and that a foreign power can with one stroke cut us off from a raw material far more important than coal tar dyes.

Anything which will draw attention to the development of American controlled raw rubber will serve to make this country more secure in its liberty. It may in fact be possible to convert chicle into a rubber-like gum by some process of chemistry, and then we might draw on the chicle forests of Central America.

As early as 1912, the German chemists had perfected a method for producing synthetic rubber at \$3 per pound, and we are now reliably informed that they have brought their process to a point where synthetic rubber can be produced at about \$1 per pound. This price is based on the cost of raw materials before the war.

At this moment their rubber is costing them more than this, but the fact remains that under normal conditions the German chemical factories will be able to produce synthetic rubber at about \$1 per pound. Have any of our American chemical manufacturers considered the possibilities of this new movement?

FREDERIC DANNERTH.

Rubber Trade Laboratory,
Newark, N. J.

Southern Barytes Mining

To the Editor of Metallurgical & Chemical Engineering

SIR:—Barytes (to use the trade term) is being produced on an immense scale in the Southern States at the present time, due to the German supply being cut off, and an increasing demand from lithophone manufacturers, chemical works and a great variety of other manufacturing plants.

In the Cartersville, Ga., district, the ore occurs as large and small lumps, in loose and extensive deposits, mixed with clay. It is mined by steam shovels, and put through log washers to float away the clay and yield a white product. Some of the washers are equipped with jigs to clean the small sizes. The amount of material available is very large. Barytes in such de-

posits is pretty sure to be free from sulphides which are present in the mineral from some underground mines. There are many known vein deposits of barytes, it is probable that deposits of this class result from the weathering of rocks containing barytes veins.

Similar deposits exist elsewhere in Tennessee, Georgia, Alabama and Virginia, but they are less developed, and in some cases at least the mineral is contaminated with other minerals, usually limonite.

In the Western North Carolina district, which was formerly an important producer, the mineral is raised from vein deposits. Large ore shoots have been worked to considerable depth. In some cases these shoots are as thick as 16 feet of the pure mineral. Below the zone of oxidation, which is quite deep, the barytes has a bluish color due to the dissemination of very fine galena (with no silver). The walls are generally both granite with slate near, or one granite and one slate wall. One possible explanation of the origin is, that the feldspars in the granite contain barium, and the extensive decomposition of the granite furnished soluble barium compounds, while the oxidation of the pyrite in the slates furnished ferrous sulphate. A fissure vein forming a natural outlet for these waters, drew the waters from each side, and eventually closed up with the precipitate.

Barytes of high purity (compared with most other raw mineral products) is put on the market at low prices, according to United States Geological Survey, as follows:

State	1912		1913		1914	
	Tons	Value per Ton	Tons	Value per Ton	Tons	Value per Ton
Missouri.....	24,530	4.77	31,131	3.78	33,317	3.37
Tennessee and Kentucky.....	3,718	2.34	2,098	1.70	8,932	1.61
Other States.....	9,230	2.99	12,069	2.91	9,298	2.91

It is probable that these figures do not include the cost of transportation to the railroads, and loading, and possibly are intended to cover the actual cost of production only at the mine.

Occasionally deposits of barytes are heard of in the Northern States and Canada. Conditions for production of high quality goods are more favorable in the Southern States, however. The glacial deposits have hidden many of the mineral resources of the Northern States, and also the depth of oxidation is in general slight.

In the Southern States, the vein barytes deposits have been found inclosed in decomposed and oxidized formations to depths of several hundred feet, but still in place, and at other points the original formation has been totally obliterated but with the product otherwise undisturbed or transported, and not covered up with other material. As explained before, barytes from oxidized zones is better quality, due to the oxidation of sulphides and leaching of soluble mineral contaminations.

Due to the cessation of imports, the mining of barytes is at present reasonably profitable, but with the resumption of imports coming in as ballast at low rates, it is feared that the industry will be reduced to its former unsatisfactory condition.

We venture to assert that there are large possibilities ahead for the manufacturers of barium chemicals and products. The raw material exists in large quantities and can always be bought at reasonable prices.

Box 843, Asheville, N. C.

SANDY BOTTOM BARYTES MINES,

Coming Meetings and Events

American Society of Mechanical Engineers, New York, Dec. 5-8.

Joint meeting of New York sections American Chemical Society, Society of Chemical Industry, and American Electrochemical Society, New York, Dec. 8.

American Association for the Advancement of Science meets with American Chemical Society and also with the four national engineering societies, represented at the Engineering Societies Building, New York, Christmas week, 1916.

American Institute of Chemical Engineers, New York, Jan. 10-13, 1917.

The Niagara Power Crisis

"The help that should within be sought,
"Scorn from without to borrow—

"If ill at others' hands ye bear,
"The cure is in Your own." *Ourselves Alone*,
JOHN O'HAGAN.

The Cassandras who for years have been making gloomy forecasts of a power famine in Niagara Falls are now saying "I told you so." Here is the situation at present:

Canada, thanks to the activities of the Ontario Hydro-Electric Commission, has been taking more and more electric power from the Niagara River, and now finds herself running short. Since Canada made a treaty with the United States about the diversion of water from Niagara Falls she has encouraged the development of hydroelectric power to the fullest extent, and this power has hitherto found its larger market in the United States. The Canadians, however, with admirable foresight, have kept their own ultimate interests in view, and consequently the power companies on the Canadian side of the river have revocable permits for exporting power. Thus these power companies can be forced to supply power to Canadian users when they want it.

One result of this arrangement in the past has been the steadily increasing migration of United States electrochemical industries to Canada. This works automatically. When, owing to the relative scarcity of power on the United States side of the river, an electrochemical industry found difficulty in having its requirements met, it turned to Canada, was received with open arms and got power on most advantageous terms. Then Canada calmly sliced off a block of power hitherto exported to the United States. The difficulty of obtaining power in the United States then remained as before, and the process was repeated.

Within the last few weeks the Ontario Hydro-Electric Commission has made a big demand on the Canadian Niagara Power Company for more power. When it was pointed out to the Hydro that this could not be done without seriously embarrassing some of the power company's United States customers the Hydro replied in effect: "We don't care a cent for your United States customers."

Now one of these customers is the Acheson Graphite Company, which supplies several important munitions works in England. The Englishmen, in great alarm, on hearing the effect of Canada's demands, promptly sent a protest through the British Minister of Munitions to the Imperial Munition Board in Ottawa asking mercy of the Ontario Hydro-Electric Commission. But the Hydro was as the deaf adder who stoppeth her ears. Moreover, the Canadian Government has hardened its heart and will not let the power go if its own people want it.

There is no question as to the logical attitude of the Canadians. According to the treaty with Canada the United States is entitled to take 20,000 cu. ft. of water per second, and it actually takes 15,600 cu. ft. Some years ago, when it was desired to generate more power at Niagara Falls on the United States side of the river, this was prevented by the Burton bill, which forbade the use of the remaining 4400 cu. ft. of water. At the end of three years the prohibition of the Burton bill lapsed, but additional water could only be used by permission of the Secretary of War. At the present time the power companies in Niagara Falls, N. Y., have sufficient equipment to utilize much more than 15,600 cu. ft., but for some occult reason Secretary Baker will not grant a permit. Therefore, the Canadians say in effect: "If you want more power why don't you go ahead and use it. If you cannot get your government to allow you to use water to which you have a perfect right, why should we deprive our people of power to satisfy your demands?"

As always happens in affairs of this sort, the real sufferers are the innocent bystanders, the people of the United States. That is one of the advantages of democracy. No one imagines for a moment that the shortage of power caused by Secretary Baker's attitude is going to ruin the power companies; probably the effect will be just the opposite; nor will it ruin any of the power companies' customers, although the cutting off of their power supply will undoubtedly diminish their business to a serious extent. The real sufferers will be those who depend upon the Niagara Falls products. The user of all kinds of steel into every ton of which Niagara Falls ferrosilicon enters as a necessary constituent, the inhabitants of all the cities throughout the country depending on Niagara Falls chlorine for purifying their water supply, the machine shops absolutely dependent on Niagara Falls abrasives, the automobile manufacturers, the gold miners, and so on. The unfortunate "ultimate consumer" will soon find that for some mysterious reason the cost of hundreds of articles which he uses every day of his life has increased.

At its meeting in New York, Nov. 24, the Board of Directors of the American Electrochemical Society took up the matter of the Niagara Falls power crisis on the recommendation of the society's committee on public relations, and directed the president to send the following communication to the Secretary of War:

To the Secretary of War, Washington, D. C.

Sir:—The Committee on Public Relations consisting of the President and Past Presidents of the American Electrochemical Society reports to the Board of Directors that owing to the large demand for power in Canada a considerable block of power now imported to this country will be cut off. The shortage of power in the United States caused by this Canadian demand will have a serious effect on our electrochemical industries.

Protests to the Canadian Government by the electrochemical industries of the United States are met by the reply that the Canadian Government must consider the interests of its own people first. It is therefore apparent that in order to assist our electrochemical industries in this emergency our government must be appealed to. The Committee on Public Relations, therefore, recommends that the Board of Directors of the American Electrochemical Society should communicate with you urging you to permit the temporary diversion of the 4400 cubic feet of Niagara River water allowed by our treaty with Canada, until such time as Congress can take action in the matter.

After careful consideration the Board finds that in view of the serious crisis threatening the electrochemical industries of Niagara Falls, N. Y., it can strongly endorse the solution of the problem proposed by the Committee on Public Relations.

In endorsing the recommendation of the Committee the Board does not desire to offer any advice as to the ultimate disposal of the 4400 cubic feet of water allowed to the United States by its treaty with Canada; but simply to

emphasize the fact that the threatened power shortage is a serious menace to the welfare of our country since this is so largely dependent on the products of electrochemistry.

As an example showing how the power shortage will affect an important industry the Board respectfully calls your attention to the inclosed letter. The facts set forth are the more interesting in that the products of this factory are an absolute necessity to many other electrochemical industries. Thus, these are not only affected directly by the power shortage, but are indirectly embarrassed through their inability to obtain a sufficient supply of material necessary for their manufacture.

This is but a single example out of many which could be given, and the Board therefore begs to offer you its services in supplying any further information you desire as to the need of our electrochemical industries. Yours respectfully,

Francis A. J. FitzGerald,

President, American Electrochemical Society.

Niagara Falls, N. Y., U. S. A.

Nov. 23, 1916.

Mr. F. A. J. FitzGerald,
Pres. Am. Electrochemical Society,
Niagara Falls, N. Y.

Dear Mr. FitzGerald:—So many electrochemical industries are being affected by the present shortage of power, that it seems to us this matter should be taken up by the Public Relations Committee of the American Electrochemical Society, and by them presented to our Secretary of War in order that he may see the seriousness of the situation. In order to give you and the Committee some information on this subject, we will review as briefly as possible our own experience.

We have always tried to keep our producing capacity very greatly in excess of our actual output, so as to be ready to take on new business in any amount and make prompt deliveries. During the past few years we have had equipment capable of manufacturing about twice as much graphite as we have actually made. When business began to increase, due to the war-stimulated demand, we put in another large electric furnace unit so as to keep ahead of our customers' requirements. In past years the limiting feature of our manufacture has always been our producing units, as there was quite a surplus of power which we could use when needed. During the past year, however, the demand for power in the United States has increased, and the Ontario Hydro Electric Commission has commandeered large blocks of power which were formerly exported to the United States. These two facts have produced a condition where the limiting feature in our manufacture is the matter of power instead of a question of equipment as formerly. At the present time we are equipped to take approximately 10,000 e.h.p. 24 hour power, but owing to the power shortage we are able to get only 53 per cent of our requirements, which means that we are now operating at about 53 per cent of our capacity.

We have recently been informed that the Ontario Hydro Electric Commission have made a further demand upon the Canadian Niagara Power Company for 15,000 e.h.p. to be delivered Dec. 1, and if the Power Company finds it necessary to deliver this amount of power to the Hydro Electric Commission on that date, we will be cut down to 30 per cent of our requirements. In other words, we will then be forced to run at only 30 per cent of our capacity.

Recently some of our English customers who are manufacturing munitions for the British Government, sent a protest through the Minister of Munitions in England to the Imperial Munitions Board at Ottawa, asking that the Ontario Hydro Electric Commission be as lenient as possible with the Canadian Niagara Power Company, as any further withdrawals of power would limit our ability to supply electrodes. We also wrote to the Provincial Secretary of Ontario, stating that withdrawals of power were curtailing the output of some of the British munition factories, due to our inability to supply them with electrodes, and asking that the matter be taken up with the Ontario Hydro Electric Commission. To all of these protests, however, the Hydro Electric Commission have been deaf, and have insisted upon having more power delivered to them, and, as stated above, have demanded an additional 15,000 e.h.p. on Dec. 1. While the information we gave the Provincial Secretary is absolutely true, yet it must be remembered that a very large percentage of our output is sold in the United States. At the present time, probably 75 per cent of our output is sold to manufacturers in the United States, who are absolutely dependent upon us for their supplies.

As you probably know, we are now building near Buffalo a new plant at a cost of approximately \$750,000, to take power from the steam generating station of the Buf-

falo General Electric Company. This new plant will give us a very large capacity, and we hope with its aid to be able to take care of our business very comfortably. However, we will naturally depend upon our Niagara Falls Plant for a considerable amount of output, and if the power situation here does not improve, we can only operate our Niagara Falls plant at 30 per cent of its capacity. The Niagara Falls Power Company have a permit to take sufficient water above their regular allotment to operate two extra machines, which generate about 12,500 hp.

While we are not familiar with the exact terms of this permit, we understand that the Niagara Falls Power Company was formerly allowed to use this extra water from 7 a. m. to 6:30 p. m., but that this permit was to expire when the first turbine of the Buffalo General Electric Company was put in service. We also understand that recently the Secretary of War has modified the terms of this permit so as to allow the Niagara Falls Power Company to use these two extra wheels during the peak period of the day, and solely for the benefit of the Buffalo load. It seems to us, therefore, that under the stress of present conditions, the War Department might at least extend the permit to use the additional water for these two extra wheels to 24 hours per day and allow them to take this water indefinitely or until Congress legislates upon this subject. It can easily be shown that the manufacturers at Niagara Falls are of as great value to the country as those in Buffalo, and some with whom we are familiar probably manufacture articles of more value and of greater necessity to firms all over the United States than anything manufactured in Buffalo. We therefore feel that this matter should be presented to the Secretary of War, who we feel sure will see the reasonableness of our position. Not only do we feel that we are as much entitled to relief under the present conditions as those elsewhere, but we cannot see that the withholding of this permit during the night is of any advantage to the Falls or to navigation on the Great Lakes, and we also feel that if the War Department can see its way clear to allow this water to be used during the summer and fall of 1916, they ought to be willing to have it used in the winter and spring of 1917. The reason we urge the extension of this permit is that it seems to be the only possibly chance for immediate relief.

The power situation here divides itself into two phases. First, there is the question of greater permanent development, which we earnestly hope will be permitted in the near future. Second, there is the question of immediate action to give the existing power companies all the water they can use at once, keeping, of course, within the treaty limits. As to the first phase, we feel that public opinion and the pressing necessities of the situation will bring favorable action from Congress. As to the second phase, we believe that the only hope for relief will be a decision of the Secretary of War, and we further believe he would not be establishing any vested right nor taking any chance in allowing more power to be generated during the interval from the present date until Congress sees fit to act. If there is any question about this, we feel sure that the Secretary will give us the benefit of the doubt.

We are, of course, interested in the future development of more power at Niagara Falls, and we earnestly trust this will be brought about. We are, however, intensely interested in getting immediate relief, for we will soon be running at only 30 per cent of our capacity, because the Canadian authorities are looking after the interests of their manufacturers.

Trusting the Committee will take this matter up and be successful in getting immediate action by our Secretary of War, we are, Yours very truly,

Acheson Graphite Company,
Acheson Smith, Vice-Prest. and Gen'l Mgr.

In Niagara Falls the electrochemical manufacturers are awaiting anxiously the action of Secretary Baker. Every effort on their part to influence him has so far been useless or worse, for apparently our learned Secretary puts them in the same class as George Washington and the soldiers of Valley Forge. In his most recent edict in the power crisis he has permitted some relief to Buffalo for lighting and power service, but expressly stipulated that not 1 kw.-hr. of energy thus doled out should go to the electrochemical manufacturers.

The situation of the electrochemical manufacturers in facing their angry customers all over the country is bad now, but they tremble to think of what it will be when on Dec. 1 Canada makes its next cut in power export.

Non-Ferrous Metal Market

Nov. 25—A stronger tone is evident in all the metals. Copper, tin, spelter, antimony and silver have all made advances during the past two weeks, and while the Trust price of lead remains unchanged, independents are asking higher prices. Conservative interests are issuing warnings that if prices of commodities continue to advance as they have been, a crash will come sooner than expected, and the higher we go the greater will be the fall.

Copper.—The difficulty of finding sellers has caused further advances in copper prices. On Nov. 13, 32.50 was asked for electrolytic and lake, while on the 14th it rose to 33.00, on the 17th 33.50, and on the 20th 34.00 cents was asked, which price prevails at present. First quarter of 1917 is offered at 33.50 and second quarter at 32.50, with the last half offered at 30.00 cents cash New York. Exports up to Nov. 24 were 14,979 long tons.

Tin.—Straits tin was quoted on Nov. 13 at 43.87½ cents asked. On the 14th it rose to 44.37½, on the 15th to 45.00, and on the 23rd 45.50 cents was asked. A serious situation in spot tin is liable to develop if the granting of permits is not facilitated. The foreign market seems to be influenced by reports of heavy business and big demand in this country, and the London market has been steadily advancing. Very few offers for future delivery Straits are being made. Arrivals up to Nov. 21 were only 1250 tons, but there is reported by the American Metal Market over 2000 tons still due this month.

Lead.—No advance in the price of lead has been made by the Trust, and its official price is still 7.00 cents New York for spot metal. Independents are asking 7.25 for spot at New York, and the opinion seems to prevail that a further advance by both Trust and independents may be looked for. Exports up to Nov. 24 were 1327 tons.

Spelter.—Spelter is in a much stronger position. On Nov. 13 it was quoted at 11.42½ cents asked, New York, on the 17th it had risen to 12.30, and on the 23rd sellers were asking 12.92½ cents. Brass mills have been heavy buyers, and futures have been in good demand, forcing prices up.

Other Metals.—*Antimony* is active again, and has risen from 13.00 cents on Nov. 13 to 14.50 on the 23rd. No quotations are available on American antimony, the above being for Chinese and Japanese. *Aluminium* continues the same, at 64.00 cents bid and 66.00 asked. *Metallic magnesium* is offered at \$3.50 per pound, electrolytic *nickel* at 50.00 cents, *cadmium* at \$1.50, *quick-silver* at \$80.00 per flask, *platinum* at \$105 per ounce, *cobalt* at \$1.50 per pound, and *tungsten ore* at \$16 to \$17 per unit. *Silver* has risen from 71¾ on the 13th to 73⅛ on the 23rd.

The Iron and Steel Market

Announcement was made on Nov. 23 that sales of Lake Superior iron ore had fixed prices for the season of 1917 at an advance of \$1.50 over prices ruling for 1916, or at \$5.95 for old range Bessemer, \$5.20 for old range non-Bessemer, \$5.70 for Mesabi Bessemer and \$5.05 for Mesabi non-Bessemer, on Lake Erie dock. The base ore contains 55 units in the case of Bessemer and 51½ units in the case of non-Bessemer. Settlements are made on a unit scale, with some divergences by way of special premiums and penalties on ores running far from the base, phosphorus content in the case of Bessemer ores, etc. The 1914 schedule of

prices was the lowest since 1905. In 1915, through some accident, Mesabi ore was 5 cents lower, and this divergence was made up for 1916 by old range ores being advanced 70 cents and Mesabi ores by 75 cents, so that the 1917 schedule represents a total advance from 1914 of \$2.20 per ton.

Fifty cents of the advance for 1917 goes to the lake vessels, as the carrying rate was recently established, by large chartering for the season, at \$1 net to the vessel, against 50 cents as the standard rate in the season just closed. There is in addition an unloading charge of 10 cents paid by the shipper. The loading charge at upper lake ports is absorbed in the regular rail freight from mine to dock.

The major portion of the prospective pig-iron production of the merchant furnaces in the first half of 1917 was sold recently at substantially the going market for this year's deliveries, while sales for the second half of next year did not begin until large advances had occurred. Basic iron was sold freely for the first half at about \$18, valley furnaces, but the first important sales for second half occurred at \$24, and still higher prices have since been paid. The merchant furnaces can therefore face the stiffest advance that has occurred in iron ore since the advance from 1899 to 1900 with much more equanimity than various smaller advances that have occurred meanwhile, frequently at a time when the pig-iron market was near the end of an advancing movement.

On Nov. 21 the United States Steel Corporation announced a general advance in wages, on the part of its subsidiary companies, amounting to about 10 per cent, and to become effective Dec. 15. An advance by Jan. 1 was more or less generally expected, but the early announcement occasioned some surprise. No question arose as to the action of independents. As labor conditions are aligned advances made in any quarter most perforce be general. The present advance is the third of the year, the others having become effective Feb. 1 and May 1. The first occurred after various labor troubles had broken out, particularly in the Youngstown district, though not affecting immediately the Steel Corporation's plants in that district, while the second advance occurred when trouble was evidently brewing. The present advance does not seem to have been preceded by a similar degree of unrest, but is obviously in keeping with the continued increase in the cost of living. No special labor shortage is felt at this time, as outdoor construction work of various descriptions is necessarily curtailed.

In iron and steel operations the most serious menace has been with respect to transportation. The acute scarcity of cars at coal mines, which developed weeks ago and resulted in some steel works buying spot coal at from three to four times the price at which coal was due them on contract, was expected to be relieved by the closing of lake navigation, and relief was also expected as to cars for coke, and the more serious apprehensions were felt as to supplies of flats and gondolas, and to a less extent of box cars, for the shipment of finished steel products from mills. Early in November conditions were growing more serious, and considerable quantities of finished steel were piled, though not enough to interfere seriously with production. The establishment of various embargoes by the railroads, and their strenuous efforts both to move cars more expeditiously and to induce shippers and consignees to act with more expedition, aided by a continuance of mild weather, have slightly relieved the situation, which is nevertheless tense because the first really bad winter weather always ties up the

railroads more or less and they have been in no condition to stand any extra strain. It is regarded as distinctly possible that the production of iron and steel will be materially reduced this winter on account of inadequate transportation facilities.

As to steel prices it is difficult to make a comprehensive statement. Almost constantly mills are advancing prices of one finished commodity or another, and the rate of advance is quite rapid. At the same time steel prices are being more and more regarded as "nominal," in that while a mill may have a fixed price it is a question to whom, or in what quantity, or for what purpose, steel will be sold. The mills are endeavoring to pick and choose the business they will accept, but whether this represents a precaution tending to make the situation safer, or discloses a belief that the condition is unsafe, might well be a subject for debate. One comprehensive statement can be made, that using a weighted average of the various finished steel products, excepting standard steel rails, the advance from the low point of December, 1914, to this date is almost precisely three times the amount required to bring prices up to the top level of 1907, the highest level between 1902 and 1916. The comparison is of prices "for delivery at mill convenience" and not of the premium prices paid for many commodities for early delivery.

On Nov. 15 announcement was made of an advance of \$5 a ton in standard steel rails to \$38 for Bessemer and \$40 for open-hearth, f.o.b. mill. The railroads were given no advance notice, and indeed for several weeks prior to the announcement of the advance the rail mills were somewhat indisposed to entertain inquiries. A rather curious incident in this period was the mailing of an order for 25,000 tons of rails, without previous negotiation. In the case of the advance of \$5 a ton effective on May 1 last several weeks' notice was given, railroads being permitted to place orders for 1917 delivery, for replacement purposes, at the old prices, \$28 for Bessemer and \$30 for open-hearth. It was in February, 1901, that the \$28 price had been established, there being no change in 15 years except that when open-hearth rails became a regular market commodity they were placed at \$2 a ton above Bessemer.

Pig iron prices have been advancing very sharply, at an average rate of about 20 cents per business day. Even at a given moment prices are not clearly defined, there being divergences as to tonnages and deliveries, and frequently in a given market a price has advanced \$2 a ton practically over night, with no sales of moment occurring at intermediate prices. Using a weighted average, pig iron at this writing in the United States stands at about \$26, f.o.b. furnace, against about \$12.50 at the low level in the first half of last year.

The Western Metallurgical Field Flotation

Some Devices Used to Regulate the Flow of Oil in the Flotation Process.—At the Inspiration Mill at Miami, Ariz., a bucket elevator with variable speed is used. At the mill of the Miami Copper Co., Miami, Ariz., the oil is contained in a barrel on a scale. The oil flows into a tank in which a float is so arranged as to keep the level of the oil constant. The outflow of the oil is taken care of by a regulated valve.

The appliance used at the mill of the Chino Copper Co., Hurley, New Mexico, consists of a tank, which is fed by as many faucets as there are oils used to make up the mixture used in flotation. Metal discs rotate vertically in this tank. They are immersed to a certain

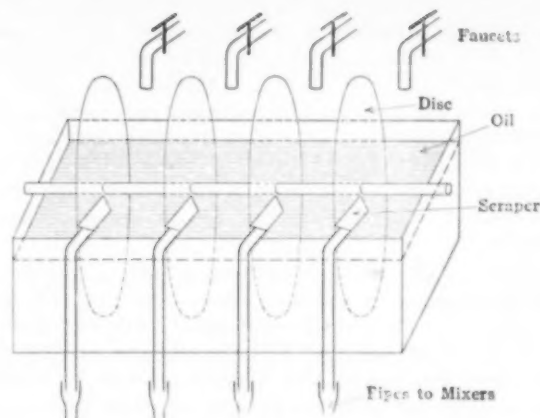


FIG. 1—PRACTICE AT CHINA MILL

depth in the oil. The number of discs depends on the number of mixers to be supplied. On one side each of the discs is a metal scraper of certain width, which scrapes off the oil from the disc. The oil scraped off flows through suitable pipes into pipes leading to the mixers. (See Fig. 1.)

The apparatus used at the new mill of the Vindicator consists of a tank holding the oil, in which rotates a

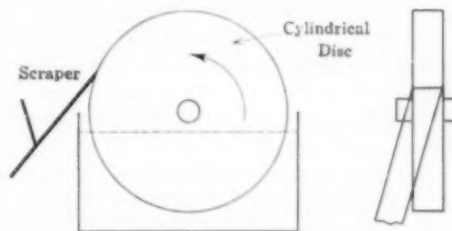


FIG. 2—PRACTICE AT VINDICATOR MILL

cylindrical disc. As at the Chino, this disc is partly immersed in the oil. The scraper in this instance comes in contact with the cylindrical part of the disc, thus scraping off the required amount of oil. The number of discs used will depend on the number of mills to which oil has to be added for mixing. (See Fig. 2.)

"Air Flotation."—Mr. William H. North of the Sutton, Steele & Steele Mining, Milling & Machinery Co. of Denver, Col., is visiting Joplin with the view of introducing a new dry process of ore concentration. Those other sections of the zinc milling districts will be visited where water supply is scarce. Mr. North's process, for which the term "air flotation process" has been coined, not only eliminates the use of water, but it is claimed to make a 2 per cent greater recovery than the water-cleaning concentration process used almost exclusively throughout the district.

In a general way, the process requires an ordinary rock crusher to prepare the ore-run dirt for separation. However, rolls giving special mesh are part of the specifications of the new method. The mesh obtained by the rolls range from 0.02 in. to $\frac{3}{8}$ in. A fan is used in the separation process, the force of the fan separating the waste from the free ore, permitting the cleaned ore to fall into a special bin, while the gangue goes to another bin.

Company Reports

The annual report of the *Tonopah Mining Company*, ending with February, 1916, gives the following data of interest: Few changes have been made in the mining methods. Ninety-six thousand seven hundred and thirty-five dry tons of ore, averaging \$14.41 per ton, and

39,462 dry tons of dump ore, averaging \$11.09 per ton, were shipped to the mill. The total mining cost per ton was \$4.31. The estimated value of the total ore assets on March 1, 1916, is \$798,789.00. The estimated tonnage is 53,493, including ore on dumps. The estimated value per ton is \$14.93.

No changes to speak of were made at the mill. It is impossible to make cost comparisons between this year's and last year's operations, due to the abnormal increase in the cost of supplies due to the war. In spite of the above-mentioned factors, the year shows a \$0.035 per ton milled decrease on direct costs, and a decrease in the total cost of \$0.077. In the months of January and February, 1916, the tonnage milled was reduced from 400 tons per day to 250.

Meeting of New York Section of Society of Chemical Industry

A meeting of the New York Section of the Society of Chemical Industry was held in Rumford Hall, Chemists' Club, on Friday evening, Nov. 24. The chairman, Dr. JEROME ALEXANDER, presided.

IMPORTANCE OF IMPURITIES

Two very interesting papers were presented, the first being read by Dr. Alexander on "The Importance of Impurities." The paper dealt with the influence of very small percentages of impurities in substances, and pointed out that many apparently inexplicable changes in structure and properties could be traced to minute quantities of impurities. A large number of examples were given illustrating this fact. This is a subject which warrants the closest attention and should always be borne in mind when some unusual change occurs. One of the best known examples as cited by Dr. Alexander is the influence of very small percentages of arsenic on the conductivity of copper. In electrolysis small percentages of impurities greatly effect the results, especially in plating; for example, a small amount of copper gives gold plate a red shade. Impurities are sometimes beneficial and sometimes detrimental, but they should always be taken into account. Dr. Alexander emphasized especially the need for great caution in reusing shipping containers. They should be thoroughly clean and no contaminating substance should be present as even the smallest amounts of a foreign substance sometimes cause great trouble.

TECHNOCHEMICAL PROBLEMS

Dr. RAYMOND F. BACON, director of the Mellon Institute of Industrial Research of Pittsburgh, read a very interesting paper, in which he outlined a large number of industrial problems which might be successfully attacked by our universities in their laboratories, in coöperation with the industries. For the university to coöperate with the industry it is necessary that there be a liberal exchange of problems for research and the industries must take a broader view of the subject, and not withhold necessary information.

Among the problems mentioned by Dr. Bacon were the following: concentration of brown ores of Carolina, Tennessee, Alabama, Texas and other Southern States, numerous blast furnace problems, such as the action of considerable amounts of vanadium in the furnace; utilization of gases; use of slags in ceramics. A substitute for magnesite for refractory use is badly needed, zirconia being too costly. A serious problem is the better utilization of domestic magnesite. The treatment of zinc flotation concentrates, the manufacture of retorts of higher tensile strength and greater durability, leaching of oxidized copper ores, acidity of gases from copper and lead smelters, new tonnage uses for sulphur

and arsenic, selective flotation of minerals, uses for alkaline earth metals (including alloys of calcium and their application in melting and casting of metals), chromium electroplating, production of pure titanium and zirconium, greater economy in processes of molybdenum concentration and extraction, chemical character of coal, production of smokeless fuel, determination of quality of and changes caused in oils by Fuller's earth, regenerative heating in the pottery industry, the great need for suitable refractories for high-temperature experimental work—these are some of the problems which are awaiting solution.

In the organic field first and foremost is the coal tar products industry and dyes from other sources; other problems are: new uses for pitch, use of tar from light oil, new peaceful uses for benzol and toluol, cause of corrosion in tar stills, uses for creosote oil, gasoline from coal gas (more applicable to and now under consideration in England, a non-petroleum-producing country) use of oil shale deposits, research in cotton industry as to value of various fertilizers and bleaching stained cotton, butter substitutes from soya bean oil, wax from sugar cane, ammonia recovery in beet sugar manufacture. A physicochemical problem is the action of light in manufacture of chlorides of carbon and as a catalyst in various reactions.

The above mentioned subjects do not include quite all of those mentioned by Dr. Bacon, but it is evident that there is no lack of problems awaiting solution. The field for chemical and metallurgical research of a practical nature is unlimited.

Chemistry in the Gas Industry

The third annual joint meeting of the New York Sections of the Illuminating Engineers' Society and the American Electrochemical Society, held in the United Engineering Society Building on Nov. 9, proved very interesting and enjoyable. Mr. W. Greely Hoyt presided.

Two papers were presented. The first, by Mr. W. R. ADDICKS, vice-president of the Consolidated Gas Co., gave "Some Notes on Gas Standards." The second paper, by Mr. ELMER L. KNOEDLER, on "The Most Recent Developments in Incandescent Gas Mantles." Both papers are published in full elsewhere in this issue.

Both papers were discussed together. Mr. Young, of the Public Service, pointed out the "wonderful developments in the gas-lighting industry." Mr. Forestall spoke of the great importance of adopting the heat-unit standard. Mr. Serrell said that a standard Bunsen burner was needed just as the electric lighting industry has a standard base and socket.

Dr. Fink asked whether any difficulty had been experienced with the artificial silk fiber in impregnating it with the thoria-ceria mixture. Dr. Knoedler replied that a better and much more uniform absorption is obtained with artificial silk. A very heavy mantle is used for railroad lighting, since high-pressure gas can be employed. After a vote of thanks to the authors of the papers the meeting adjourned.

Before the meeting there was a very sociable and splendidly managed informal dinner at Keene's, in a private room, with musical entertainment.

Exhibit of Electrochemical Products in New York Museum of Natural History

The American Electrochemical Society plans what should be a very interesting exhibit of electrochemical products at the New York Museum of Natural History. This will be arranged in connection with the New York convention of the American Association for the Ad-

vancement of Science during the last week in December, 1916. The attendance at the Museum during the meeting is expected to reach over 5000.

This exhibit will form a section of a general exhibit of scientific and technical products. Prof. H. F. Osborn, president of the Museum of Natural History, has assigned to the American Electrochemical Society four display cases, 8 ft. long and 2½ ft. wide and each company's exhibit will occupy about one and a half square feet. The exhibits are to be properly tagged with the name of the product and name and address of the manufacturers. The tags are to be white and are limited in size to 3 in. by 8 in.

Manufacturers, interested in the exhibit, are requested to send samples of electrochemical products, and also samples of important raw materials at the earliest possible moment to Dr. Colin G. Fink, care of Museum of Natural History, Columbus Avenue and Seventy-seventh Street, New York City.

Dinner to Dr. Takamine and Dr. Hirsch

"In honor of Dr. Jokichi Takamine and Dr. Alcan Hirsch on the occasion of their departure for Japan to collaborate, at the invitation of the Japanese government, in the development of the Japanese dye industry," Mr. Joseph P. Devine, president of the J. P. Devine Co., gave a dinner on Saturday, Nov. 18, in the East Room of the Waldorf-Astoria, New York.

Nearly forty professional friends of Drs. Takamine and Hirsch attended the function, which was exceedingly enjoyable.

The Japanese Dye Company, formed after the beginning of the European war to manufacture dyes for the Japanese market, is a private company subsidized by the Japanese government in so far as the government has guaranteed the interest on the capital provided by the investing public of Japan. This company selected Drs. Takamine and Hirsch and Mr. Devine to collaborate with them in the starting and development of the undertaking; and on the eve of the departure of Drs. Takamine and Hirsch for a three months' trip to Japan Mr. Devine tendered them this dinner.

Mr. Frank A. Palen, sales manager of the J. P. Devine Co., acted as toastmaster. The keynote of his introductory remarks was that "there is no greater factor in diplomacy than cordial business relations." Mr. Joseph P. Devine outlined his cooperation with the Japanese dye makers and emphasized his desire that they should have the advantage of our development here so as to eliminate mistakes that could not be avoided by them without previous experience.

Dr. Jokichi Takamine gave a most interesting sketch of the evolution of modern industrial and scientific Japan, while the speech of Dr. Alcan Hirsch (or Hiruchi Hakasi, by which name and title he will be known in Japan) was a fine generous expression of thanks to his friends.

Dr. Charles F. Chandler was, as ever, delightful in his recital of Takamine reminiscences; so was Dr. Charles Baskerville, who concluded with remarks on the function of science as an international catalyser; "out of all the present war turmoil science must bring about unity of nations and unity of purpose." Dr. Marston T. Bogert emphasized that in the present rapid development of industrial chemistry in this country the shortage of highly trained men, able to perform the more difficult research work, was a serious handicap. Dr. Thomas H. Norton, in the final set speech of the evening, gave interesting statistical figures of American and Japanese dye production and consumption, and paid a tribute to "the men who have so swiftly designed

and built the digesters, the sulfonators, the autoclaves, and all the manifold machinery of the color factory, and to whom our young American industry owes its rapid evolution."

Current News and Notes

Fused Silica Company Changes Hands.—The firm of Fensterer & Ruhe of 37-39 Murray Street, New York City, have recently bought the controlling interest in the Sidio Company of America, Inc., manufacturers of fused silica (quartz glass). The company's factory is being enlarged and in a short time will be completed. The New York office is at 37 Murray Street. The officers of the company are now Otto Trautmann, president; Walter J. Fensterer, vice-president; S. Herlinger, secretary; and Francis H. Ruhe, treasurer.

Electric Steel in San Francisco.—The Pacific Foundry Company of San Francisco has installed a Rennerfelt furnace of 750-lb. capacity. While not the first electric steel plant on the Pacific Coast, it is the first electric steel plant in San Francisco.

Gift to United Engineering Library.—Dr. James Douglas of New York has presented \$100,000 to the United Engineering Society, the income to be used for the benefit of the library. The trustees of the society have perfected plans for the development and the extension of the usefulness of this great engineering library and are endeavoring to secure endowments aggregating \$1,000,000, the income to be used for the library. The plans of the trustees having been submitted to and carefully examined by Dr. Douglas have been approved by him and he has signified this approval by his gift of \$100,000, which has just been made. Now that the library of the American Society of Civil Engineers has been united with the libraries of the Institutes of Mining, Mechanical and Electrical Engineers in the building of the United Engineering Society in West Thirtieth Street, New York, the combined library forms the greatest engineering collection in the world. It is the purpose of the trustees to greatly extend its usefulness and it is hoped that the splendid indorsement which Dr. Douglas has given will stimulate other similar endowments until the necessary \$1,000,000 has been obtained.

The Cutler-Hammer Mfg. Co., Milwaukee, Wis., has issued a booklet describing magnetic switch control apparatus for the iron and steel industry.

Messrs. Sill & Sill, consulting mining and metallurgical engineers of Los Angeles, Cal., have issued an "ore testing" bulletin giving an illustrated description of their facilities for testing ores and metallurgical processes.

Painting with a Gun.—The Spray Engineering Company, Boston, Mass., has issued a bulletin describing its new "paint gun," a device for applying all kinds of liquid coatings by the spraying method.

Fans.—The B. F. Sturtevant Co., Boston, Mass., has issued catalog No. 240, describing Sturtevant electric fans for various uses. Three types are shown; centrifugal, propeller and disc fans. A separate bulletin No. 228 has also been issued giving dimensions, capacities, etc., of design No. 3 multivane fans, which type was developed to have a larger outlet area for a given volumetric capacity, giving a higher mechanical efficiency at a lower velocity for a given maintained resistance.

The little monthly publication "Power Notes" issued by the Diamond Power Specialty Co., Detroit, Mich. has just been increased in size. The paper is available for all those interested in power plant work.

On the Formation of Columnar and of Free Crystals During Solidification

By Henry M. Howe

Let me try to explain why, in steel ingots, the formation of a columnar structure resembling that of the Palisades of the Hudson is favored by the use of cold iron molds, by "too much fire" as the crucible melter says, and in general by molten superheating: how it happens that "free crystals" form and sink to the bottom of the ingot; and why in the cross section of the ingot the transition from the columnar to the equiaxed structure is usually abrupt.

The underlying condition which leads to these several results is that each molten particle in the act of freezing splits up into a part poorer in carbon which freezes, and another part richer in carbon which, because its enrichment in carbon lowers its freezing point, fails to freeze.

THE COLUMNAR STRUCTURE

This arrest of the freezing, when as in Fig. 1 the littoral molten layer has thus been enriched in carbon and its freezing point has thus been lowered to below the existing temperature, is only temporary. The progressive cooling would itself soon bring the existing temperature down to the freezing point of this enriched layer, but apart from this the freezing point of this layer is quickly raised up to the existing temperature by the shoreward diffusion of unenriched deep sea metal. This soon dilutes the carbon content of this littoral layer enough to raise its freezing point up to the now existing temperature, when it in turn freezes.

This diffusion clearly feeds the freezable deep sea metal faster to the tips of the pine-tree crystals which protrude from the already solid shores into the molten mass than to their lateral branches, so that growth tends to take place fastest at these tips. Hence the columnar form. Moreover, rapidity of cooling exaggerates the

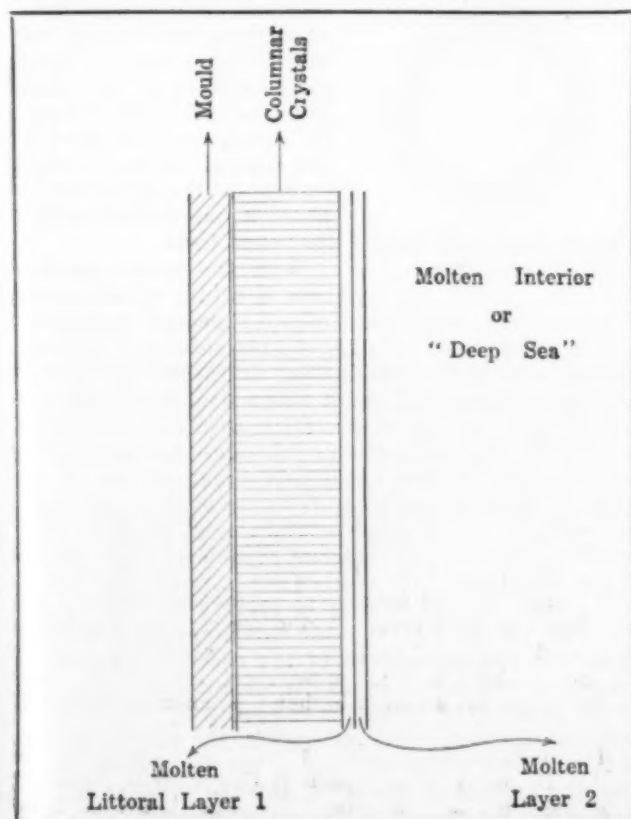


FIG. 1—PART VERTICAL SECTION OF A SOLIDIFYING STEEL INGOT

advantage which these tips have in this regard, and so does quiet, because the existence of irregular convection currents would tend to feed deep sea metal to the ends of the lateral branches.

The use of chill molds, then, by hastening the cooling, favors the growth at the tips of the existing pine-tree crystals, or in other words favors the formation of columnar crystals.

Molten superheating favors quiet, and through quiet the columnar structure, probably in part by decreasing the quantity of dissolved gases, and hence by postponing the period when those gases become so concentrated in the residual molten as to supersaturate it, and hence to begin escaping, because it is probable that the solubility of gas in molten metals, as in aqueous liquids, decreases as the temperature rises. In the case of the crucible process, both long and high heating further favor quiet by increasing the silicon content of the molten metal, for they lead to the reduction of silica from the walls of the crucible and from the slag. A like action occurs also in the acid open-hearth process.

A distinct way in which rapidity of cooling, quiet, and molten superheating lead to rapid freezing is their increasing the undercooling, the degree to which the temperature sinks below the freezing point before freezing starts, with the result that, when this undercooling once breaks up and freezing actually begins, it proceeds with extreme rapidity, indeed almost instantaneously, with the shooting out of columnar crystals, a shooting which is retarded progressively as the heat evolved by the solidification raises the temperature of the metal toward its freezing point.

THE FORMATION OF FREE CRYSTALS

Because the heat can escape only through the sides, top, and bottom of the solidifying ingot, the temperature naturally rises as we pass from the outside toward the axis. Because the molten metal in immediate contact with the already solidified part of the ingot should thus be somewhat cooler than that farther off from these walls, solidification would naturally be expected to occur only where the molten abuts against the walls, so that every new particle of pasty solid which forms should attach itself to them. How then can free crystals form at an appreciable distance from the walls? Let me offer an explanation based on this same principle of the differentiation which occurs in freezing. Let us call the layer of molten metal of Fig. 1 immediately in contact with the already solid walls Layer 1, and that next farther from them Layer 2. At any given moment Layer 1, enriched in carbon by the freezing of the last deposited relatively carbon-poor layer, is richer in carbon than layer 2, and hence has a lower freezing point. Hence freezing may occur in layer 2 before it does in layer 1, because the general fall of temperature may bring layer 2 to its somewhat higher freezing point before it brings layer 1 to its somewhat lower one, and thus solid nuclei may form in layer 2 while layer 1 is still molten. These nuclei, lacking contact with the solid walls, are in fact "free crystals." As each of these particles in layer 2 freezes, it breaks up in turn into a part poorer in carbon which freezes, and a part richer in carbon which remains molten. Hence each little nucleus which thus freezes is in turn poorer in carbon than the molten metal in which it is suspended, hence it is heavier than that metal, and hence it sinks to the bottom. The accumulation of sinking free crystals explains the usual impoverishment in carbon of the lower axial part of ingots which are segregated.

As with the progress of solidification the thermal gradient becomes flatter and flatter, while the carbon-gradient probably becomes steeper and steeper, the layer of most active solidification should move farther and

farther axisward, or in other words solidification should occur at points farther and farther away from the already solid walls.

These considerations evidently apply to solidifying liquids in general, and even to those cases in which gases pass directly to the solid state. They apply even to so-called pure metals and other pure substances, provided that they contain dissolved gases, which concentrate progressively in the residual molten as other dissolved substances do.

WHY THE TRANSITION FROM THE COLUMNAR TO THE EQUIAXED REGION IS ABRUPT

During the early part of the freezing the thermal gradient is so steep that our layer 2, in spite of being poorer in carbon than layer 1, yet does not in cooling reach its freezing point before layer 1. Whether layer 2 can reach its somewhat higher freezing point earlier than layer 1 can reach its somewhat lower one will clearly depend on how much hotter layer 2 is than layer 1. So long as the difference in temperature between layers 1 and 2 exceeds the difference in their freezing points, layer 1 will freeze before layer 2. It is only when this condition is reversed and the difference in temperature is less than that in freezing point that layer 2 can be the first to freeze. But this difference in temperature must clearly decrease as the thermal gradient flattens with the progress of solidification. This means that at a certain moment during solidification the progressive flattening of the thermal gradient will at last cause the difference in temperature between layers 1 and 2 to become less than their difference in freezing point. Up to this moment freezing has been taking place exclusively in contact with the already solid walls, and hence has been of the columnar type. From this time on free crystals form which are not in contact with those walls, and this arrests the prolongation of the columnar structure. Hence the abruptness of the transition from the columnar to the granular type of solidification.

A column prolongs itself by causing its orientation to be adopted by each new lot of solid which deposits at its existing tip, and this it must needs cease to do when it meets the crystalline growth shooting out from such a nucleus formed in Layer 2, because this latter growth will already have the orientation given by its own nucleus. Once the growth of the column has thus been interrupted, there is nothing to cause it to start again. Hence both the permanence and the abruptness with which each column, on meeting such an independent growth, loses its power of prolonging itself.

Further study may, indeed, show that variations in the relation between the thermal gradient and the freezing-point gradient form an important underlying cause of the favoring of the columnar structure by rapid freezing, quiet, and molten superheating. Evidently rapid cooling, by steepening the thermal gradient, must needs postpone the moment when the temperature difference between adjoining layers becomes less than their freezing-point difference, and in this way it favors the columnar structure. A high casting temperature would have a like effect.

We can arrive at the full explanation of these complex phenomena only by trial and error. As we amplify our explanations and bring in new principles, we indeed explain more and more of the phenomena, but we may find still a residue of facts which we cannot yet explain fully. This residue proves that still another principle remains to be discovered. By taking each of these little steps in explanation we help to the final true solution, our very failures stimulating others to try where we have failed.

Bedford Hills, N. Y.

Notes from the Palmer Physical Laboratory

A Mechanical Property of Certain Magnetized Bodies

By E. F. Northrup

The writer, while experimenting with an impedance used in some alternating-current measurements, observed an interesting phenomenon in connection with this impedance. The impedance consisted of a bundle of soft-iron wires, all of equal length, which formed the core of a solenoid. This solenoid was proportioned somewhat as shown in section at *S* and in end view at *E*, Fig. 1. It was about 30 cm. in length.

Some of the iron wires having been removed from the solenoid as originally constructed left the remainder loosely crowded together within the solenoid. On applying to this solenoid a heavy alternating current, the wires near the axis of the solenoid began to slowly move out of the solenoid, although this latter rested in a horizontal position on the table.

After a brief time the wires in the solenoid had assumed the position indicated by the dotted lines in *S*, Fig. 1. They extended from one end of the solenoid to form the cone included between the points *a*, *b*, *c*, on the diagram, there being, of course, at the other end of the solenoid a corresponding hollow cone marked by the dotted lines *a-c* and *b-c*.

In seeking an explanation of this phenomenon the wires were pushed back within the solenoid so that their ends formed level surfaces at each end of the solenoid. It was then found on applying the current that the extended cone of wires could be made to form itself at either end of the solenoid by giving one or more of the central wires a slight thrust in the direction in which it was desired to have the cone form.

With the above observation as a hint to start from

it was easy to make the following general deduction:

If a thick sheet of magnetizable substance be magnetized with north magnetism uniformly distributed over one surface and south magnetism uniformly distributed over the opposite surface, then any elementary cylinder of this magnetizable substance, having its axis perpendicular to the upper and lower planes of the sheet is, when located away from the edge of the sheet, mechanically in unstable equilibrium. Conceive this small cylinder of the material capable of free motion in the direction of its axis. Then it is evident that if the cylinder be moved ever so short a distance in the direction of its axis the end which projects slightly above the general surface of the sheet will acquire a polarity of the same sign as the magnetism of that side of the sheet above which the end projects. But now, as poles of like sign repel each other, the projecting end of the cylinder will be repelled by the magnetism spread over the surface of the sheet and the cylinder will be pushed out of the sheet its entire length. This will occur so suddenly that its momentum will carry the



FIG. 1—SOLENOID WITH MOVABLE CORE

lower end of the cylinder slightly above the surface of the sheet. But this lower end of the cylinder will now acquire by induction magnetism of the opposite sign to that spread over the surface of the sheet, and the cylinder will have its lower end attracted and brought into contact with the surface of the sheet in the near neighborhood of the hole from which it made its exit, and will there remain standing in a position in which its axis is normal to the surface of the sheet.

To test the above deduction one of the writer's former students, Mr. Dudley Willeox, constructed, at the writer's request, the piece of apparatus which is illustrated at *S* and *T*, Fig. 2. We called this piece of apparatus our magnetic "Jack-in-the-Box." The name is seen to be well applied when the performance of this magnetic curiosity is witnessed. A word respecting its construction before describing the manner in which it works. *I*, shown in vertical section, was a cylinder made of ordinary cold-rolled steel shafting. A hole approximately 3 mm. in diameter was drilled along its axis entirely through it. The bottom end of this hole was fitted with a small brass plug 3 mm. long and a hole in this, to admit air, was drilled lengthwise. A rod of soft iron, *i*, was made to accurately fit this hole, but left free to move within it without friction. The iron core *I* was wound with several layers of No. 16 copper wire. In Fig. 2 are shown the various parts as proportioned and of natural size. To make our Jack-in-the-Box more entertaining the upper end of the movable iron rod *i* was capped with a piece of sheet brass, to which a piece of cardboard could be glued with the smiling face of our Jack-in-the-Box painted upon it.

When to this device a magnetizing direct current, derived from 48 volts of storage battery, was suddenly

applied by closing a switch and keeping it closed, the central rod *i* would spring upwards and assume the position shown in dotted line in Fig. 2. The suddenness with which the rod *i* would move up out of the solenoid and assume its position, standing on top of the iron core piece *I*, was such that the eye could not follow the motion.

It is evident that, if the diameter of the movable portion *i* of the iron core be chosen nearly equal to the diameter of the immovable portion *I*, the movable portion instead of showing a tendency to be projected upwards and out of the solenoid would be, as is usually

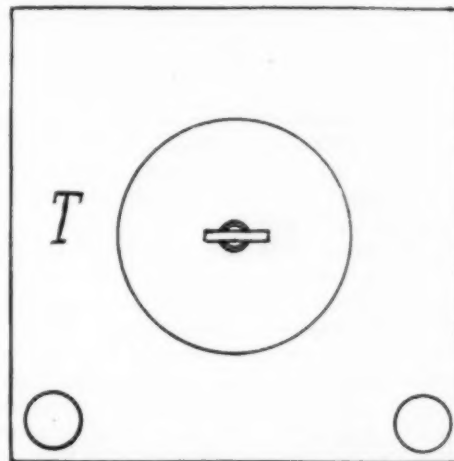


FIG. 2b—TOP VIEW

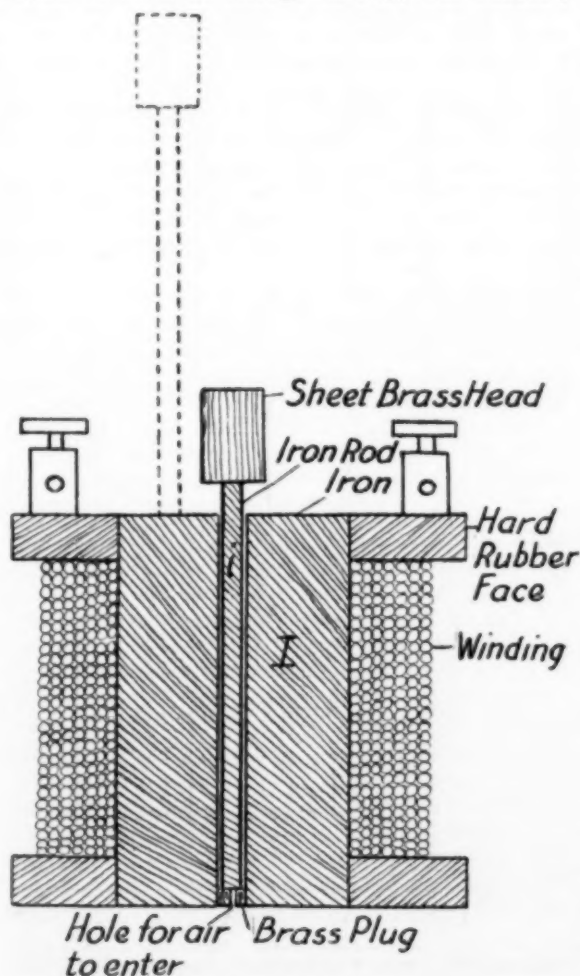


FIG. 2a—MAGNETIC JACK-IN-THE-BOX

observed, drawn into the solenoid. It follows that it would be possible to so choose the diameter of the movable portion of the core that on energizing the solenoid this iron core-piece would have neither a tendency to be sucked into the solenoid or to be projected out of it. A similar result could be obtained by decreasing the magnetic permeability of the immovable portion of the core *I* while keeping the size and permeability of the movable portion *i* unchanged.

The writer takes this occasion to suggest that experimenters should endeavor to hold a mental grip on chance observations of apparently trifling phenomena until they have deduced all the consequence which can possibly be drawn therefrom. The cultivation of a mental habit of this kind will rarely fail to lead the investigator to matters of much interest and often of large commercial utility.

Palmer Physical Laboratory, Princeton, N. J.

Coals of Canada.—The Mines Branch of the Department of Mines of Canada, has issued a bulletin (No. 338) entitled "The Weathering of Coal," by Dr. John B. Porter. The report is a supplement to Bulletin 83 on the coals of Canada issued in 1910. It contains the results of an extended investigation.

Dust Collecting and Conveying Apparatus.—The B. F. Sturtevant Company, Boston, Mass., has issued catalog No. 235 describing Sturtevant dust collecting and conveying apparatus.

Stoneware Atomizing Nozzles for Acid Chambers.—Stoneware atomizing nozzles, as a substitute for glass nozzles in acid chambers, have been placed on the market by the Monarch Manufacturing Works of Philadelphia, Pa. There is claimed to be no danger of breakage due to temperature changes, and they are not affected by acids such as sulphuric, nitric, etc. The inner part (sprayer) is also made of stoneware and is loose-fitting so that no adjustment is needed when replacing the inner part after cleaning.

Determination of Light Oils in Coal Gas and Description of Still for Separating the Light Oils from the Absorbing Oil

By D. H. Duvall

Chemist, Coke Plant, Bethlehem Steel Company,
Maryland Plant, Sparrow's Point, Maryland.

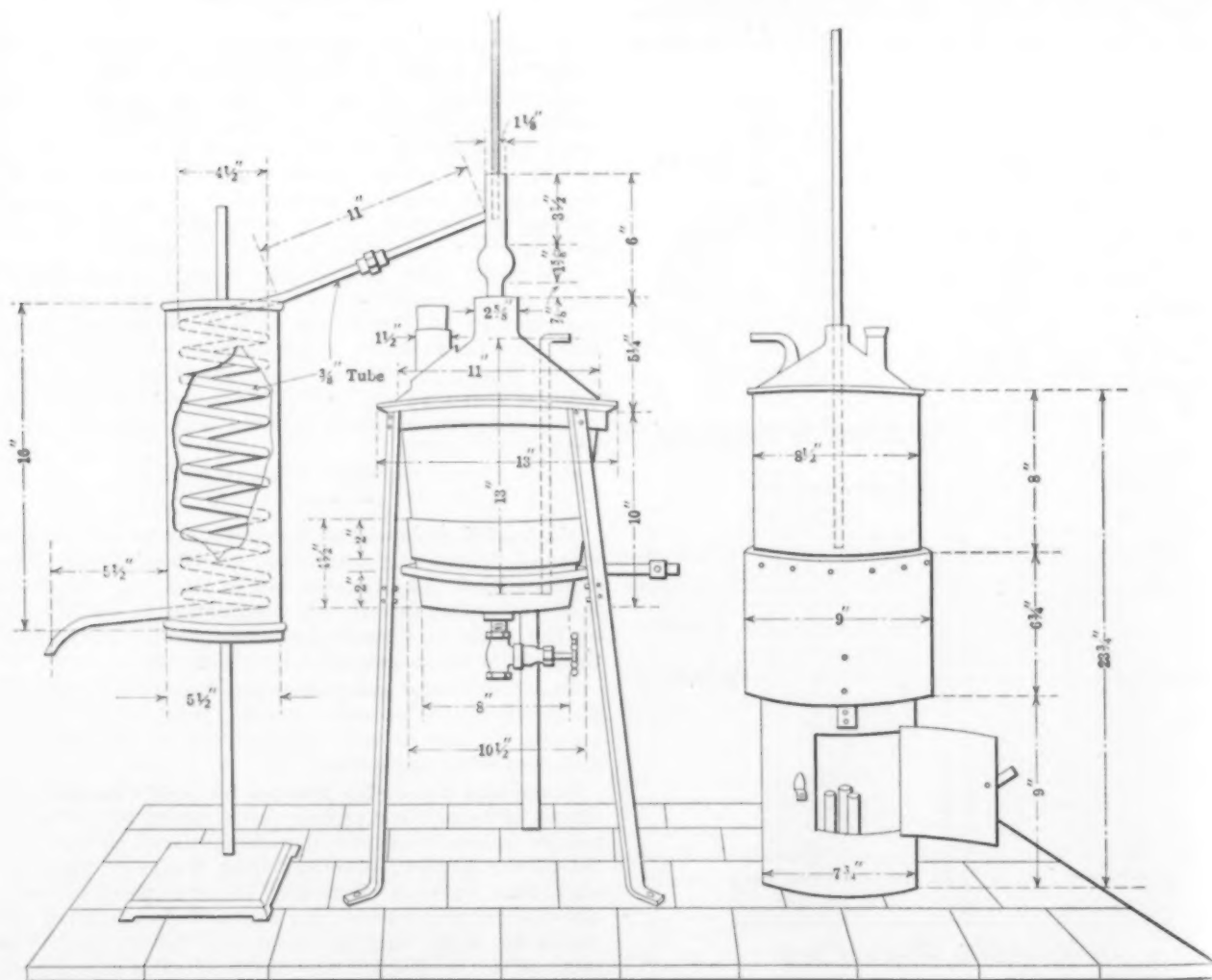
The recent development of the light oil recovery in connection with by-product coke plants in this country has made it necessary to determine the quantity of light oils in the gas (both before and after scrubbing) to show the efficiency of the operation. Since determinations are required frequently, it is necessary to employ a method that will lend itself readily to routine laboratory work. From various laboratory methods we have developed an apparatus which has met the necessary requirements very satisfactorily, and owing to numerous requests for information regarding this apparatus we take this opportunity to give a brief description of the method and apparatus.

Before proceeding with the description of the apparatus it will be necessary to give a brief outline of the method for those who are not so familiar with it. The complete test consists of the absorption of the light oils by some absorption medium and the separation of the light oils from this medium. The first part of the test is accomplished by freeing the gas from hydrogen sulphide and naphthalene by means of a solution of sodium hydrate for the removal of the hydrogen sul-

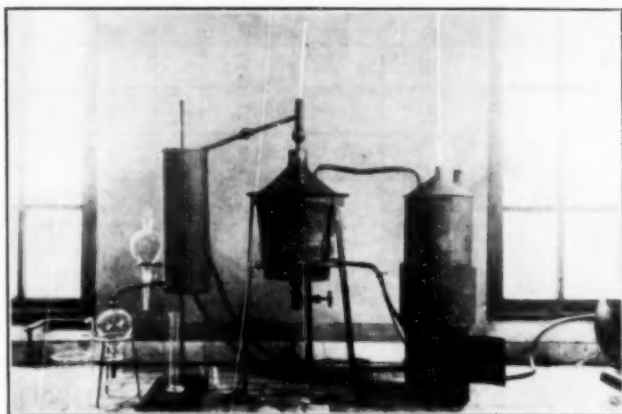
phide and a solution of picric acid for the removal of naphthalene, then removing the light oils by contact with a suitable absorption medium, preferably oleic acid. The absorbing solution is placed in a train of five or six bottles, each bottle containing about 1000 to 1200 c.c. The gas passes from the train through a wet gas meter, by means of which the corrected volume is determined. The rate at which the gas is passed is from 3 to 4 cu. ft. per hour, depending upon the quantity of light oils in the gas.

The second part of the test consists of the separation of the light oils from the oleic acid, which is accomplished by means of the still shown in the photograph and sketch. The still, which is made of 12-gage copper, is shown in the sketch, with proportions and actual dimensions, while the photograph shows the still as arranged for use. It has capacity great enough to hold sufficient oleic acid to scrub enough gas to produce an accurately measurable quantity of light oils without enriching the oleic acid to a point where complete absorption would not be obtained. The condenser attached to the still gives the distillate sufficient cooling contact to insure perfect condensation of the oil vapors. The benzolized oleic acid is poured into the still through the filling cap at the top and the debenzolized oil (after the distillation is complete) is drawn off through the valve at the bottom of the still, without breaking any connections or moving it out of position.

Heat is applied to the still by means of the circular Bunsen burner shown in the sketch. The orifices of



DETAILS OF APPARATUS FOR DETERMINATION OF LIGHT OILS IN COAL GAS



APPARATUS FOR DETERMINATION OF LIGHT OILS

the burner are drilled at an angle of 45 deg., so that the tips of the flame will strike against the 2-in. wide copper band sweated on to the still as a reinforcement to prolong the life of same.

The still is heated until the temperature at the top is 80 deg. C., then the temperature of the oil is about 100 deg. C. When this temperature is reached, steam from the generator is introduced into the still by means of stout rubber tubing connection. The temperature at the top of the still rises rapidly to 100 deg. C. and then increases slowly to 180 deg. C. The temperature of 180 deg. C. can be reached in an hour without the slightest danger of boiling over the contents of the still.

The distillate from this operation is drained of water and a dry distillation made in a 200 c.c. side neck Engler flask to get rid of excessive oleic acid, which is carried over mechanically during the process of distillation. The distillate from this dry distillation is now saponified with sodium hydrate to remove the last traces of oleic acid, washed with water to remove the products of saponification and sodium hydrate, drained of water and dried with calcium chloride, after which a fractional distillation is made in a 200 c.c. side neck Engler flask.

Having given the volume of gas used in the test and the quantity of oils as obtained from the last fractional distillation, we are enabled to calculate the theoretical oils contained in a gas. Knowing the volume of gas produced per ton of coal carbonized and the quantity of light oils obtained per ton of coal in our operation, we can easily determine the efficiency of our plant operation by comparing the theoretical results with the results actually obtained in operation.

Electric Power Development in Norway.—Approval has been given by the local authorities of Gjerstad and Bremanger, Norway, to raise loans to develop water power for electrical industries in those localities for lighting and electrochemical industries. The communal administration of Jevnaker, Lunner, Gran and Grandbu have appropriated \$134,000 to enlarge the Hadeland electric station. The Bremanger Power Co. will erect a factory for producing carbide and cyanamide, producing 30,000 tons of carbide per year, of which one-third will be used for making cyanamide. A French-American syndicate is considering the erection of a large electrochemical plant in the Telemarken district, using 100,000 hp. from the Maar Falls in Tinn.

The B. F. Sturtevant Company, Boston, Mass., has issued catalog 235 describing Sturtevant fan systems for collecting dust and conveying materials.

Manufacture of Potassium Chlorate

By Anson G. Betts

The electrolysis of potassium chloride solution results in the formation of chlorate, but special means have to be employed to make the process successful enough to be commercial.

The first attempts to produce chlorates electrolytically were made with carbon anodes and carbon or iron and other metallic cathodes constituting a very inefficient plant, cathode reduction destroying the product about as fast as produced.

The addition of magnesium chloride or calcium chloride was tried, on the theory that a deposit of the corresponding hydrate on the cathode would hinder the reducing effect of the cathode. A laboratory trial of this procedure will convince any one that the benefit of these salts is very little.

The patent of Imhoff disclosed a beautiful process. Platinum electrodes are used, with a neutral solution containing a soluble chromate and a very high current efficiency is the result. Considering the ease of recovering the product in crystal form, by merely cooling the electrolyte, this manufacture is extremely easy and simple.

At the present time potassium chlorate is selling at many times the normal price. The high price of potassium chloride accounts for this to a partial extent only.

Presumably the supply has not kept pace with the demand because while the Imhoff patent has expired, platinum electrodes are required, and platinum at present prices is not an attractive large investment and heavy interest charges have to be figured on.

The process of the writer solves several serious obstacles in the way of profitable production of potassium chlorate, at this or at any time.

Experiments show that the electrolysis of alkaline chlorides with carbon anodes and magnesium cathodes¹ give a high current efficiency and low cathode reduction of the product.

The use of a very open diaphragm is desirable, not dense enough or close enough to make an absolute separation of the anode and cathode liquors, but to impede the free circulation in the cell only. The result is the maintenance of an acid reaction near the anode and a basic reaction at the cathodes. The acid anolyte has a minimum destructive effect on the anodes and accelerates the conversion of hypochlorite into chlorate, and depresses the amount of oxygen liberated, while the basic reaction of the catholyte prevents the corrosion of the cathode. A bank of glass rods separated by small spacing, hung or supported between the electrodes gives the desired effect.

For raw material, it is proposed that feldspar be utilized. By heating ground feldspar with lime and salt, and lixiviating, a solution of salt and potassium chloride is readily obtained.² As a means of producing potassium chloride, the necessity of separating these salts might deter anyone from working this process, but in the manufacture of chlorate the mixed chlorides can be electrolyzed and the potassium chlorate crystallized out. The cost of the raw material by this procedure is certainly reasonable and cheaper than potash salts.

Using feldspar as raw material, the cost of production with water power figures out roughly at about 6 or 7 cents per pound of potassium chlorate under present conditions.

Asheville, N. C.

¹Bureau of Soils, U. S. Dept. of Agriculture—Circular No. 71.

²U. S. Patent, A. G. Betts, 918,650, Apr. 20, 1909.

Possibilities in the Wet Treatment of Copper Concentrates*

By Lawrence Addicks

At the San Francisco meeting of the Institute last year I presented, through the courtesy of Dr. James Douglas, some results of experiments on the roasting and leaching of concentrator tailings.¹ After it became apparent that flotation rather than leaching was clearly the better method of handling the particular problem under consideration, before dismantling the experimental equipment, some data was secured on roasting and leaching the concentrate itself in competition with smelting. Some of the results obtained are given in the following paper and they are of particular interest at this time in view of the large quantities of flotation concentrates with their somewhat difficult smelting characteristics now being produced.

A complete wet process (patent applied for) consists

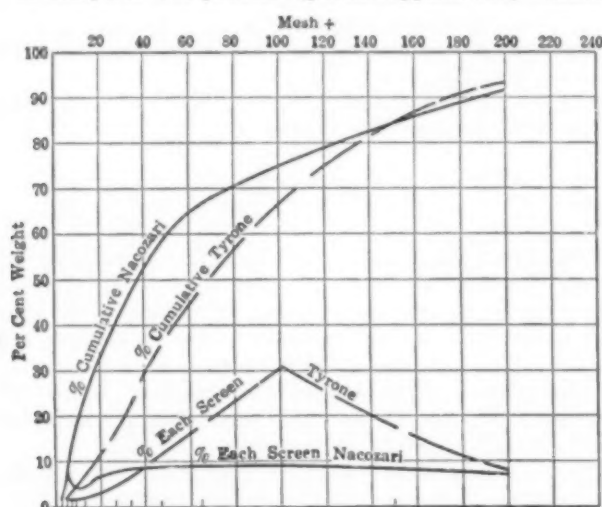


FIG. 1—SCREEN ANALYSIS OF CONCENTRATES CALCINES

of roasting and leaching the calcines in dilute sulphuric acid produced from the roaster gases, roasting the residue with salt and leaching with dilute tower liquors (the well-known Longmaid-Henderson process) and recovering the copper, silver and gold by cementation or electrolysis or a combination of both. It is evident, however, that the residue from the first leaching, carrying about 20 per cent of the copper and all of the silver and gold, can be smelted if preferable. In considering the application of the scheme to individual cases, it must be remembered that freight plays a large part in any reduction process wherein smelting is not conducted at the mouth of the mine, and that it is not practicable to-day to build small smelting plants for individual operations.

The experiments may be grouped under four main heads: Roasting, leaching, chloridizing residue, and recovery of copper from solutions. The products of two concentrators were used: The Nacozari concentrates were the product of a large modern mill not using flotation, the copper mineral be-

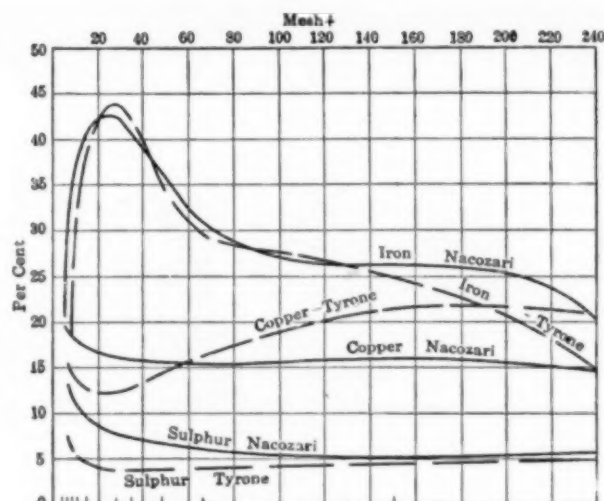


FIG. 2—VARIATION OF COMPOSITION WITH SIZE OF PARTICLE

ing largely chalcophyrite; and the Tyrone concentrates, the product of an experimental mill including flotation, the copper mineral being chiefly chalcocite. Typical analyses would be as follows:

	Nacozari	Tyrone
Copper, per cent	14.0	14.0
Silver, ounces per ton	4.0	0.5
Gold, ounces per ton	0.01	Trace
Iron, per cent	31.0	28.0
Sulphur, per cent	34.0	30.0
Silica, per cent	13.0
Alumina, per cent	3.0
Lime, per cent	0.6

Fig. 1 shows screen analyses of calcines obtained by dead roasting the two concentrates as described later. Fig. 2 shows the analysis of the calcines for copper, sulphur and iron for each screen size. The Nacozari concentrates carry considerable coarse jig product, while the Tyrone material comes from an ore where the values are finely disseminated and the quantity of 100-mesh is quite marked. The presence of the flotation concentrates in the Tyrone material brings up the copper contents of the fine sizes.

Roasting

The object in roasting is to make as much of the

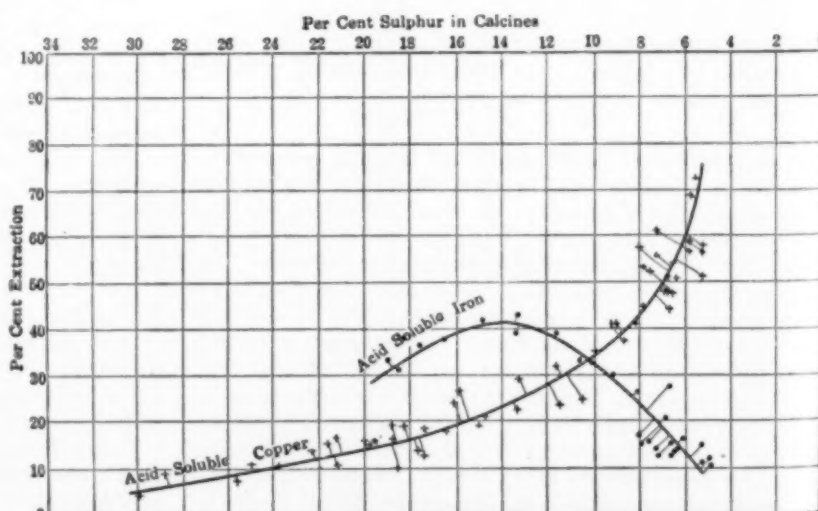


FIG. 3—NACOZARI CONCENTRATES ROASTED IN 18-FT. SIX-HEARTH MACDOUGALL FURNACE AND LEACHED IN 4 PER CENT SULPHURIC ACID IN LABORATORY

* A paper read at the Arizona meeting of the American Institute of Mining Engineers, September, 1916.

¹ METALLURGICAL AND CHEMICAL ENGINEERING, September 1, 1915.

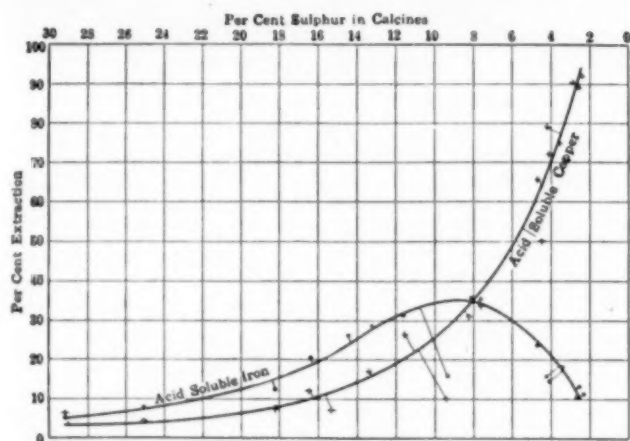


FIG. 4—TYRONE CONCENTRATES ROASTED IN 18-FT. SIX-HEARTH MACDOUGALL FURNACE AND LEACHED IN 4 PER CENT SULPHURIC ACID IN LABORATORY

copper, and as little of the iron as possible soluble in dilute sulphuric acid. The work is similar to roasting pyrites fines in sulphuric acid manufacture, except that this solubility ratio rather than the complete utilization of sulphur is the controlling factor. Small-scale work is not very satisfactory as a guide to possible results as it is practically impossible to prevent overheating due to rapid oxidation of sulphur in a laboratory experiment. An 18-ft., water-cooled, six-hearth MacDougall was used, the speed of rotation being gradually cut down until dead roasting conditions were obtained. Greater tonnages could doubtless have been obtained in a seven-hearth furnace.

Many samples were taken from various hearths and the acid-soluble copper and iron determined by leaching with 4 per cent H_2SO_4 in the laboratory. The results of these tests are given in Figs. 3 and 4. The results of tests on a series of sixth-hearth samples to determine the relation between tonnage and sulphur elimination are plotted in Fig. 5. It is evident that the chalcocite can be oxidized much more readily than the chalcopyrite, although size of particles has something to do with this. An investigation of the solubilities of the various sizes of particle are carried out by screening some of the calcines, as shown in Fig. 6. As would be expected, the finer particles are the more thoroughly oxidized; the jig product in the Nacozari concentrate is one reason for the poorer results obtained in the treatment of this material.

In general, these large-scale experiments indicate the possibility of reasonably obtaining the results desired—

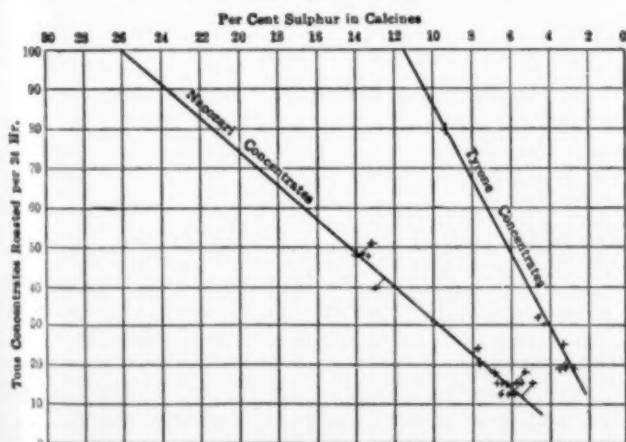


FIG. 5—ROASTER CAPACITY VS. ELIMINATION OF SULPHUR

high copper and low iron solubility—but it is obvious that the residue after leaching will contain sufficient copper values to require retreatment, aside from the fact that any silver and gold will remain in this residue.

Leaching

As shown in the paper presented last year, such satisfactory results in the extraction of copper values from tailings were obtained by dumping the hot calcines from the furnace into a leaching trough, the few seconds' agitation thus obtained extracting almost as much as prolonged treatment in other apparatus, that the same idea was tried out with the concentrate calcines. It was not possible, for various reasons, to handle the output of the furnace directly, so the calcines were stored and then fed to a bucket elevator which in turn delivered into a V-trough in which the leaching liquor was flowing.

The results were here disappointing, as although there was instant extraction of perhaps half of the soluble copper, a prolongation of the trough to give 60 sec. travel did not greatly increase this amount. It was definitely shown in the laboratory as well that prolonged agitation was necessary to extract all of the

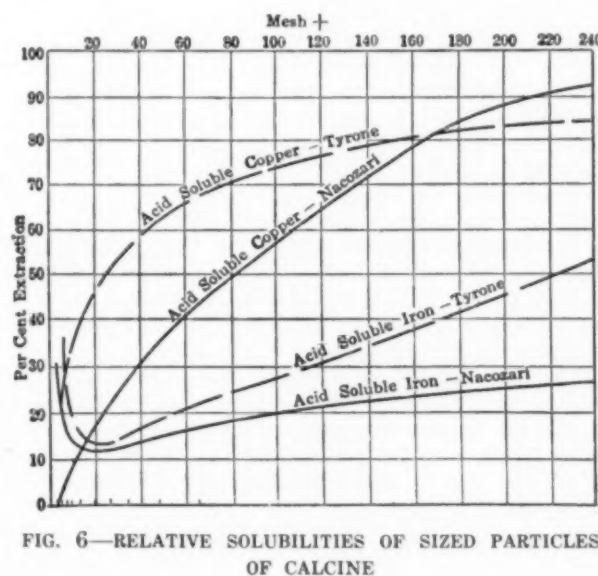


FIG. 6—RELATIVE SOLUBILITIES OF SIZED PARTICLES OF CALCINE

soluble copper. The leaching trough delivered into an acid-proof drag consisting of an endless belt with angle rakes, of the type commonly used in concentrators for dewatering. This acted more or less as a classifier, the very fine residues being carried over with the liquor, from which they were subsequently separated by settling. As this still gave insufficient agitation to the sands, a Parral tank was tried, but it was found that they were too heavy to yield readily to any sort of air-lift agitation.

A Dorr classifier was then added to the apparatus, and this did better. It was found, however, that it was necessary to pass the residues six or seven times through the leaching process in order to obtain an extraction equal to that shown by laboratory tests on the calcines.

The large-scale leaching tests were confined to the Tyrone material, a lot of 30 tons of calcines from some of the roasting tests being used. The first runs on a lot of 17 tons of not quite dead-roasted material running 4 per cent sulphur gave results that were satisfactory except in that too much iron was dissolved, causing a needless consumption of acid and embarrassing any electrolytic scheme of recovery. Later, better-

roasted material was available and a careful record kept of the metal balance and acid consumption, with the following results:

Time Through	Per Cent Cu in Tails	Through Fed	Dorr Fed
1st.....	7.7	Acid	Water
2d.....	6.0	Acid	Water
3d.....	5.2	Acid	Water
4th.....	3.6	Acid	Acid
5th.....	3.3	Acid	Water

EXTRACTION BY HEADS VS. TAILS

	Weight, Pounds	COPPER		IRON		ALUMINA	
		Per Cent	Pounds	Per Cent	Pounds	Per Cent	Pounds
Heads.....	8,360	15.48	1,292	31.00	2,590	5.60	468
Tails.....	5,600	3.50	196	43.52	2,440	7.02	393
Extraction.....		84.70	1,096	5.80	150	16.00	75
Extraction per lb. of Cu.....			1.00		0.14		0.07

EXTRACTION BY ANALYSIS OF LIQUORS

	Weight, Pounds	COPPER		IRON		ALUMINA	
		Per Cent	Pounds	Per Cent	Pounds	Per Cent	Pounds
Heads.....	51,538	0.46	238	0.20	140	0.47	246
Tails.....	86,910	1.46	1,271	0.76	657	0.45	395
Extraction.....		80.00	1,033	21.30	553	31.90	149
Extraction per lb. of Cu.....			1.00		0.53		0.14

These figures check reasonably close except in the case of iron; but it must be remembered that various iron parts in the apparatus used were attacked by the liquor, which would artificially increase the iron taken into solution.

The acid consumption was 2495 lb. of 100 per cent H_2SO_4 for the run. This is equivalent to 2.28 lb. per pound of copper extracted. Laboratory tests on the same calcines indicated 2.0 lb. The leaching was done at about 125° F. with 5.6 per cent free acid in the liquor entering the trough.

In general, when a 15 per cent copper calcine is fed to

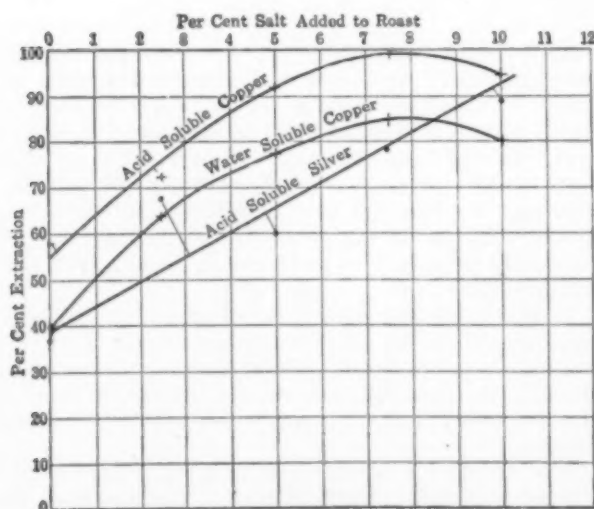


FIG. 7—CHLORIDIZING LEACHED CONCENTRATES CALCINES
Roasted 1½ hours at 975 deg. Fahr. with addition of salt and 10 per cent raw concentrates.

Calcines: 5.6 per cent copper, 1.9 oz. silver and 2.5 per cent sulphur.

Raw concentrates: 14.4 per cent copper, 0.55 oz. silver and 34 per cent sulphur.

Liquor: 5 per cent Na_2SO_4 , 5 per cent $NaCl$, 5 per cent $FeCl_3$ and 0.5 per cent $HCl + H_2SO_4$.

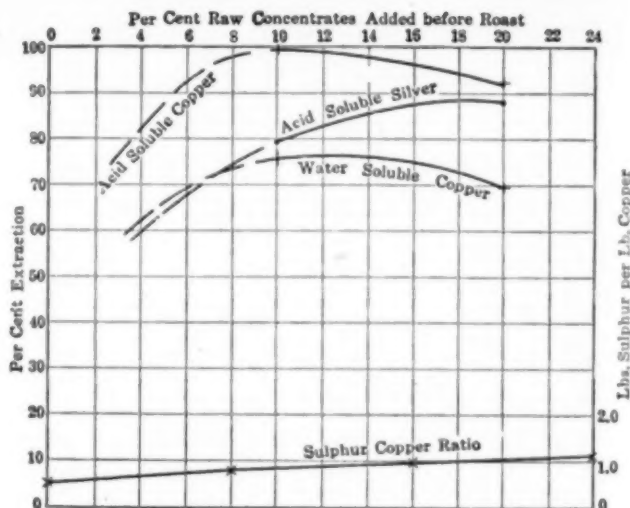


FIG. 8—EFFECT OF SULPHURIC-COPPER RATIO UPON EXTRACTION 7½ PER CENT SALT ADDED TO ROASTING "MIX"

the trough, the residue at the end of the trough will run about 8 per cent Cu, the extraction representing the instantaneously soluble copper. This residue can be brought down to about 3.5 per cent Cu by suitable agitating means, with a consumption of a little over 2 lb. of acid per pound of copper, and with the extraction of but little iron. The final residue weighs but about 60 per cent of the original concentrate before roasting.

Chloridizing Residue

No large-scale work was done on the chloridizing of the residues from the first leaching. The analysis of these residues, however, differs from that of pyrites cinder, so long successfully treated by this process, only in the amount of silica present. Various small-scale experiments were tried and 50 lb. or so were sent for test to a plant where the Longmaid-Henderson process was in operation. Both sets of experiments were entirely satisfactory.

A small lot of leached residues was prepared for test. These contained 5.6 per cent Cu, 1.09 oz. Ag, and 2.5 per cent S. Raw concentrates for adjusting the sulphur-copper ratio were used, containing 14.4 per cent Cu, 0.55 oz. Ag, and 34 per cent S. Fig. 7 shows the extractions with varying percentages of common salt added to the "mix" after roasting in an electric muffle furnace 1½ hr. at 975° F. and leaching in a liquor carrying 5 per cent Na_2SO_4 , 5 per cent $NaCl$, 5 per cent $FeCl_3$, and 0.5 per cent $HCl + H_2SO_4$. Fig. 8 shows the effect of varying the sulphur ratio. The results show a 99 per cent copper and a 79 per cent silver extraction. The report on the lot of residues sent away fully confirmed these results.

Recovery of Copper from Solutions

The liquor from the chloridizing plant would doubtless be reduced to argentiferous copper cement by iron. But 20 per cent of the original copper is involved. The sulphate liquor from the first leach could be precipitated by iron if desired, or with certain limitations would be suitable for electrolytic deposition of the copper and regeneration of the acid. The concentrates carry from 1 to 2 lb. of sulphur per pound of copper, equivalent to from 3 to 6 lb. of 100 per cent H_2SO_4 , less process losses, if the roaster gas is oxidized to sulphuric acid. Since the leaching calls for but a little over 2 lb. of acid per pound of copper, plus tailings losses, it would seem possible, therefore, to figure on a simple cementation plant, considering electrolysis as a competitor on a basis of relative profit and not of necessity.

The Cost of Coal*

By Geo. Otis Smith and C. E. Leshner

United States Geological Survey.

The price of coal is a matter of vital concern to the average citizen. No less important, however, is the question what our coal actually costs to produce and the interest in this subject is typical of the popular interest in the large productive enterprises of the country. As citizens we recognize the consumer's dependence upon the producer and are taking advanced ground as to their relative rights. In few industries does this dependence seem more vital or the consumer's equity appear larger than in that of producing and selling coal. The per capita annual expenditure for the useful metals is roughly equivalent to that for coal, but few citizens purchase pig iron or bar copper, whereas of the urban population only the dwellers in apartments, boarding houses, and hotels are spared the necessity of buying coal. The consumption of coal in the United States for heating and cooking is between 1 and 1½ tons per capita. A careful estimate for 1915 is 1.1 tons, which happens to be identical with the figure determined for similar consumption in Great Britain in 1898. This non-industrial consumption is greatest in cities and in the city of Chicago in 1912 it was nearly 2 tons. Of course, every citizen indirectly pays for his share of the total consumption, which last year amounted to 4.6 tons per capita.

Again it may be that because to a larger degree the cost of metals is charged to capital outlay rather than to the operating expense of life, we appreciate less keenly the unit price of these materials that are not immediately consumed with the using. At any rate, public opinion is more easily brought to a high temperature by considering the price of coal than by considering the price of any other product unless we except gasoline, recent discussion of which has been almost explosive.

Looking backward as well as forward, one need not be an alarmist to suggest that in the whole field of productive business the coal industry seems the one most likely to be threatened with Government operation. The foodstuffs are produced on land owned and operated by the millions, and so far as the production of the raw material for them is concerned, "monopoly" is an unknown word, but when we think of coal, terms like "barons" and "trusts" instinctively come to mind. For these reasons the determination of certain facts connected with coal production and the analysis of the cost elements that enter into the price of coal constitute a timely subject for discussion.

In discussing costs, however, we do not overlook the too evident fact that at times price may far outstrip cost. The price of coal depends upon the balance between necessity for fuel on the one hand and ability to produce and to deliver on the other; the ability to produce is in turn controlled by the labor available and the ability to deliver is dependent upon car supply. Increased foreign demand for American coal, large industrial consumption, unusual weather—all may have great influence on the current price of coal, but none of these is to be considered a factor in the actual cost of production except so far as it causes irregularity in operating expenses and promotes a decrease in efficiency of mine labor. To-day high prices are being received for coal by those who are able to produce and deliver more than their outstanding contracts require. In other words, a few traders may be able and willing to capitalize the urgent necessity of the consumer and their own ability to deliver. The premium for fuel now be-

ing paid generally by the consumers of the country and by such traders as have been caught short in their contracts is in reality not properly chargeable to cost of coal but to cost of car and labor shortage, just as in the times of stress accompanying labor troubles the premium paid by their consumers is a part of the price the country pays for strikes.

FOUR ITEMS OF COST OF COAL

Four general items of cost must be considered as normally controlling the price of coal to the consumer—resource cost, mining cost, transportation cost, and marketing cost. Under usual conditions each of these items includes a margin of profit which may seem either excessive or inadequate, according to your point of view. Yet an unbiased consideration of these cost items is absolutely essential as a preliminary to the decision by the public whether we are buying coal at a fair price, and if not why not. As long as it is the popular view that the price of coal is made up of one part each of mining costs and freight costs to two parts each of operator's profits and railroad dividends, with the cost of a certain amount of needless waste on the side, the demand for investigation will continue, and in so far as there is any element of truth in this view, legislative action is justified, even though the prescribed reform may approach the extreme of public ownership and operation of mines and railroads.

As the initial item of cost, the amount charged against the marketed product as the value of the coal in the ground, which for brevity may be termed the resource cost, is perhaps the item most often overlooked by the coal consumer, and for this reason that phase of the subject will be fully considered after the other items are treated. These other items need less discussion in this paper for several reasons: the item of marketing cost is one that can be brought directly under observation by the consumer if he will but study the matter intelligently, the transportation cost can be learned by simple inquiry and its control lies within the province of the Interstate Commerce Commission, and the details of mining cost can best be set forth by the mine operators themselves, for they have now adopted the policy of free discussion of these matters, which they once regarded as sacred from public view. The purpose of this paper, then, is simply to give a summary statement of all these elements in the cost of coal, and some special discussion of the resource cost. In presenting the subject, the senior author assumes responsibility for whatever may be regarded as mere expressions of opinion and the junior author stands behind the statements of fact.

MINING COST

The item of cost first to be considered represents that part of the value given to the ton of coal by the mine operator and the mine worker. This may be termed mining cost, but it must include the operator's selling costs and other overhead expenses as well as the mining costs proper which include the larger expenditures for wages, supplies, and power. This cost plus the resource cost—the royalty or depletion charge—and the profit or loss on the sale make up the value at the mine mouth. The mining cost varies not only between mines of different companies in separated fields but even between adjacent mines of the same company in the same field. Both nature and man contribute to such variation.

It is not practicable to assign a very exact figure to the mining cost—the census of 1909 indicated an average of \$1 a ton for bituminous coal and \$1.86 for anthracite, but these figures are believed by some operators to be too low. It is possible, however, to show in a general way the distribution of this item; the cost of

*A paper read before the American Mining Congress at Chicago on November 14, 1916.

mining is divided between labor, 70 to 75 per cent; materials, 16 to 20 per cent; general expense at mine and office and insurance, 2 to 4 per cent; taxes less than 1 per cent to 3 per cent for bituminous coal, and 3 to 7 per cent for anthracite; selling expenses nothing to 5 per cent, and recently to these items has been added the direct and indirect cost of workman's compensation which may reach 5 per cent for bituminous coal. The charges for labor, material, and general office expenses are easily understood, as is also a charge for depreciation of plant and machinery; but taxes and selling expenses are important items that may be overlooked by the casual observer. Some figures recently published show that the taxes levied in West Virginia last year on coal lands and coal-mine improvements—that is, on the industry as a whole—were equivalent to nearly 3 cents per net ton of coal produced, which is doubtless fully as much as the profit made by many of the operators in that State.

The cost of selling coal is nothing for the companies that use their own product, including the Steel Corporation and a large number of others, and is little or nothing for the producers who sell nearly all their coal to such large consumers as the railroads. Companies that produce coal for domestic use and the general run of steam trade must figure on a selling cost as high as 10 cents or more per ton, the cost depending on the extent of their business. The average selling cost for bituminous coal is probably 5 to 10 cents a ton, and for anthracite the usual charge of sales agencies is reported as 10 cents a ton for steam sizes and 15 cents for the prepared sizes.

TRANSPORTATION COST

The producers of coal and the transportation companies are concerned not so much with the actual rates charged for carrying coal as with the adjustment of rates between different coal fields and between different markets. In the many years in which our coal industry has been developing, rate structures have been built up that give to this and that producing district differentials over other districts—"handicaps," as it were—that may be based on comparative lengths of haul or on the ability of the coals to compete by reason of difference in quality or in cost of mining, or perhaps may be merely the survival of past practice, for which no reason now exists. The consumer of coal, however, is interested in the actual rather than the relative freight rate.

To help toward a realization of the magnitude of this transportation item, it may be pointed out, first, that all but 14 per cent of the output of the country's coal mines, aggregating 532,000,000 tons, is moved to market by rail or water, and second, that nearly half of the bituminous coal (47 per cent in 1915) and more than two-thirds of the anthracite (71 per cent in 1915) is shipped outside of the States in which it is produced.

Add to this statement of the extent to which coal enters interstate commerce, a glance at the distribution of centers of maximum production and maximum consumption—the New York-Baltimore industrial zone, which has a total per capita consumption of nearly 10 tons and lies 100 to 400 miles from the tributary coal fields; New England, consuming about 7 tons to the unit of population and lying 400 to 800 miles from its coal supply; or the populous industrial district of which Chicago is the commercial center, consuming 8 to 9 tons per capita of coal in part hauled more than 400 miles from the fields of West Virginia and eastern Kentucky and in part 200 miles or less from the Illinois mines. With these facts in mind we must realize that the transportation cost is necessarily a large part of the country's fuel bill.

As has already been suggested, the transportation rate in force from any coal field to any market can readily be learned by the consumer who wishes to figure this item in the cost of the coal which he buys. There fore in the present general consideration of the subject it is sufficient to state the average value of this item. In the interstate traffic, both rail and water, bituminous coal probably pays an average freight of nearly \$2 per ton. In other words, the transportation costs more than the product and, as some parts of the country are just now learning, is sometimes more difficult to obtain. The value of coal, like the value of so many other commodities, is a place value.

The average freight charge on anthracite is higher than that on bituminous coal, first because the rates are higher and second because according to the reports of the Interstate Commerce Commission, *all* movements considered, the coal is carried a greater distance.

MARKETING COST

The cost of handling the coal, exclusive of freight, from the time it leaves the producer until it is in the consumer's fuel bin, may be termed the marketing cost. It can readily be seen that a large part of the coal produced is not subject to this cost, for most large users of steam coal, such as the railroads and the coke manufacturers, place contracts directly with the producing companies or their selling agencies and buy in the open market only when their needs exceed the deliveries under their contracts. Much of the coal, however, both anthracite and bituminous, passes through the hands of a wholesale dealer or jobber before it is received by the retail dealer who puts it in our cellars or in the bins of a power plant. Coal that gets a long way from the mine may pass through many hands before it reaches the consumer, and it not only pays commissions all along the line but is subject to shrinkage and deterioration, both of which enter into the final selling price to the consumer. Brokers are usually satisfied to make a gross profit of perhaps 10 cents a ton, but as several brokers may make a "turn over" on the same car before it is unloaded this element of cost may be several times that amount.

About half of the anthracite and around 15 per cent of the bituminous coal is retailed in less than carload lots, and the greatest number of individuals are directly concerned in the marketing of this portion, regarding the profits on which there is the widest divergence of opinion. The margin in the retail business between cost on cars and price delivered is between \$1.25 and \$2 a ton and is not more than enough to give on the average a fair profit. The shrinkage and, in part, the deterioration are together seldom less than 1 per cent of the weight and may exceed 4 per cent, and the retail dealer also must provide in his selling price for uncollectible accounts.

Advertising is a large expense—in part carried by the retailer directly but all borne by the industry. The largest single item in the cost of retailing is of course that representing the labor of handling and the local cartage, which together make up about half the marketing cost.

RESOURCE COST

There now remains to be considered the first major item, or the resource cost, which is what the operator has to pay for the coal in the ground—the idle resource, which he starts on its career of usefulness. This cost is expressed as a royalty or a depletion charge.

One of the latest leases by a large coal-land owner provides for the payment of 27 per cent of the selling price of the coal at the breaker. This percentage is

therefore not only a royalty figured on the mineral resource but also a commission based on the miner's wage. To bring this right home to you and to me, it may be said that the practical result is that if the anthracite we burn in our range this winter happens to come from that particular property, we will pay fully \$1 a ton into the treasury of the city trust that owes its existence to the far-seeing business sense of a hard-headed citizen of Philadelphia. Whether such a royalty is excessive or not the fact remains that this is the tribute paid to private ownership.

The present average rate of royalty on anthracite is probably between 32 and 35 cents a ton on all sizes, which is from 12 to 14 per cent of the selling value at the mine. The minimum rate (about 10 per cent) is found in some old leases, and the maximum (20 to 27 per cent) in leases made in the last five years. R. V. Norris states that in the late sixties, when the annual output of anthracite was around 15,000,000 tons, royalties were 8 to 10 cents a ton on prepared sizes, but that no charge was made on the smaller sizes. In the seventies the rate rose to 25 cents on prepared, one-half that on pea, and one-fourth on smaller sizes. By the middle eighties, when the output was a third what it is now, the rate was about double that of the seventies—that is, 40 to 50 cents on the larger sizes and 5 to 10 cents on the smaller sizes. The tendency is still upward by reason of increases in the rates for intermediate sizes and the operation of royalty rates based on a percentage of the selling value, an increasing quantity. Figured on the output from the Girard lands, which is nearly 3 per cent of the total production, the gross return to the estate from its coal lands is over 50 cents a ton.

Nor is the increase in value of anthracite lands any less striking. At the beginning of the last century, as stated by Mr. Norris, the great bulk of these lands were patented by the State of Pennsylvania for \$2 to \$4 an acre; in the middle of the century the price of the best land rose to \$50, and in 1875 even to \$500. Now \$3,000 an acre has been paid for virgin coal land, and little is on the market at that. In considering these increases in land values, the effect of interest and taxes must not be overlooked.

The bituminous coal industry is a modern institution compared with the mining of anthracite, and much of the bituminous coal land was acquired by the operating companies during the last twenty years for little if anything more than its surface value. To-day there are large areas of bituminous coal-bearing lands that, because they are undeveloped and without railroads, can be purchased at a low price, but little or no anthracite land is on the market, and little has changed hands for years. The present average resource cost of bituminous coal is not much over 5 cents a ton, or about 4 per cent of the average selling value at the mine. In the Pocahontas region and the Pittsburgh district the royalties are much higher, but these like others that might be cited, are exceptions—one due to coal of special quality, and the other to location—factors which, incidentally, are exactly those that have assisted in making the resource cost of anthracite what it is.

Should you be interested in summing up all these various costs and striking a balance between labor's share and capital's return, you would find that the mine worker, the trainman, and the wagon driver together receive fully half of the price of the anthracite delivered at your house, and the same three classes of labor receive not less than half the price paid by the average consumer for the cheaper soft coal. In a similar manner the average return on the capital invested in land, mining plant, railroads, and coal yard may be roughly cal-

culated, with the result that landlord, bondholder and stockholder of coal company and railroad together receive about \$1.15 from the ton of anthracite and only 50 to 75 cents from the ton of bituminous coal, and of either of these amounts the mine operator's share is only a small fraction.

POSSIBILITIES OF RELIEF

It is not the purpose of this analysis of costs to offer any cure-all for the high price of coal, yet some comment on the facts presented may possess value. At least certain lines of approach can be pointed out as not very promising. For example, anyone who is at all cognizant of the trend in price of labor and material can see little hope of relief in lower costs for these items. Furthermore, observation of the advances made in mining methods in the last decade or two affords slight warrant for belief in any change of wasteful operation. As consumers of coal we might do well to imitate the economy now enforced by the producers in their engineering practice. In the Northern anthracite field machine mining is extracting coal from 22 and 24-in. beds, and throughout the anthracite region the average recovery of coal in mining is 65 per cent, as against 40 per cent only twenty years ago. Nor are the bituminous operators any less progressive in their conservation of the coal they mine.

Yet it must be remembered that conservation of a natural resource, though it will undoubtedly be of direct economic benefit in the future, is not essentially a cheapening process; in fact, these increased recoveries of coal have in large part become possible only because of a higher market price. And, following further this line of thought, we may say that the increased safety in the coal mines that has come through the combined efforts of the coal companies, the State inspectors, and the Federal Bureau of Mines necessarily involves some increase in cost of operation, but the few cents per ton thus added to the cost is a small price to pay for the satisfaction of having the stain of blood removed from the coal we buy. That form of social insurance which is now enforced through the workman's compensation laws alone adds from 2 to 5 cents a ton to the cost of coal.

In the item of transportation perhaps the most promising means of relief is that of reducing the length of haul. Though many a consumer's preference for coal from a distant field over that from a field nearer home is based on special requirements, the deciding element in the preference of other consumers is simply the price, and this in turn may be largely due to a differential freight scale, which is thus not in the public interest if we admit the premise that it is wasteful to burn coal in hauling coal into coal districts or past such districts, except in so far as quality requirements absolutely demand the long-haul coal. The recent eastward movement of the higher-grade coals, in part caused by the export demand, may involve some increase in the average length of haul, and thus in the transportation cost of coal not exported, but on the other hand this enforced adjustment may lead some consumers to discover nearer home sources of coal equally well suited to their purposes.

Reduction in marketing costs is a reform so close to the consumer that he should be able to find for himself whatever relief is possible. Professor Mead of the University of Pennsylvania is authority for the statement that the delivery of coal is costing the dealers 50 cents a ton more than is necessary.

There only remains, therefore, the first item of all—the value of the coal in the ground, or rather the return which the landowner is asking for this natural

resource. The fortunate holder of coal land, whether a very human individual or a soulless corporation or a large trust estate administered for benevolence only, is likely to endeavor to get all that the traffic will bear. Especially in the possession of a limited resource like anthracite, the tendency has been and will continue to be to increase royalties as the years pass, and the only penalty imposed by the State for high royalties seems to be high taxes, which too often, indeed, serve to justify the high resource cost put upon coal in the ground. Finally, in considering royalty rates or depletion charge we must not overlook the interest that accumulates throughout the period between the purchase of the coal land and the removal of the last ton of coal.

In placing a value upon the Choctaw lands some years ago the Geological Survey figured the aggregate royalties at current rates as \$160,000,000, but if that amount of royalty were to be collected through the six or seven centuries required for mining the 2,000,000,000 tons under this land, the present value of the land would be only \$6,500,000 if purchased by the Federal Government or only \$4,000,000 if purchased by the State of Oklahoma, and even less if the project were financed by a corporation that would need to issue 6 per cent bonds. Such is an illustration from actual experience in coal-land valuation—the \$4,000,000 to \$6,000,000 invested in these Oklahoma coal lands now would require a final return of \$160,000,000 in royalties to balance the account.

More recently Mr. Cushing, the editor of *Black Diamond*, has figured the cost of a monopolistic control of the available coal resources east of the Rocky Mountains on the basis of the United States Geological Survey estimate of two million million tons. At a valuation of coal in the ground of only 1 cent a ton, which, as he stated, is less than has been paid for large holdings, this deal would require a capitalization of \$20,000,000, and the fixed charges on the bonds of this United States Coal Corporation would require an interest charge alone of \$2 a ton against a production of 600,000,000 tons a year. Mr. Cushing characterizes such a financial undertaking in mild terms as hopelessly impossible, and yet his figures, which do not include taxes, are most enlightening as affording some measure of the cost of possessing an undeveloped resource. Incidentally, these startling figures furnish a strong argument for the present policy of the National Government in retaining ownership of the public coal lands, at least up to the time when the market conditions justify the opening of a mine and then either leasing or selling a tract only large enough for that operation. The consumer of the next century simply cannot afford to have private capitalists invest to-day in coal land for their great grandchildren to lease.

The burden that seems inevitable under unregulated private ownership of a natural resource like coal is that because the lands containing these national reserves of heat and power are taxed and because the individual or corporation properly charges up interest at current rates on his large holding, the consumer must pay a resource cost which takes into account the long period of undevelopment. Even the high rates of royalty on the lands of the Girard Estate may be found less excessive than they seem if a century's taxes and interest charges are figured. Yet the fact remains that the royalty for anthracite represents a much larger proportion of the cost of the mined coal than any bituminous royalties. Moreover, we believe the highest royalty prevailing in the anthracite region has far more influence in fixing the selling price than the lower rates of the older leases.

Any study of costs in the coal industry finds its point

in the question, not who but what fixes the price of coal. The cost of mining coal, like the cost of living, is increasing. Exact mining costs, however, cannot be determined until the operatives have accomplished their reform of standardizing accounting. Too often the operator includes in his account only the two largest and most obvious items, labor and material. Thus, when the market for bituminous coal is dull, the company whose land costs little or nothing is able to set a lower limit of price than the company whose coal must stand a charge of 5 to 10 cents per ton or even more, be that charge called royalty, depletion, or amortization. At such times the operator with the larger resource cost must sell at a real though not always recognized loss, but, of course, with the hope of recouping himself at times of high prices like the present, if fortunately he has any coal to sell not already contracted for.

Even with the average low resource cost of bituminous coal, the state of competition that is tied up with idle and half-worked mines results in an average total cost that is little below the average selling price. Of course, in this business there are those, both large operators and small, who make a profit in lean as well as in fat years, just as there are those for whom the prosperous years are too infrequent to keep them out of the hands of receivers.

In the anthracite fields the mining costs, and especially the resource costs, are higher. But here, with an average market demand that normally exceeds or at least equals the available supply (and with the passing years this disparity must be expected to increase), there results naturally a lack of competition for the market. Even gentlemen's agreements are unnecessary as long as every operator can reasonably expect to sell his product, and the market price of anthracite at the mine must, therefore, tend to be fixed by the operator who has the largest mining and resource cost rather than by his neighbor who may be doubly favored with a mine less expensive to work and a lease less exacting in terms.

Confessedly, this analysis of the cost elements that enter into the price of coal emphasizes our lack of specific facts, which can be supplied in the future only through "installation of uniform cost-keeping methods and uniform and improved accounting systems," to quote from the declaration of purposes of the Pittsburgh coal producers. With the results of such book-keeping in hand, more definite reply can be made to the public's appeal for relief from high prices. Yet even now it may be possible to suggest how that relief will eventually be obtained. Study of present conditions in the coal mining districts fails to encourage the idea of governmental operation of the 7,000 coal mines in this country. More in line with the trend of public sentiment in the last decade, however, is governmental control in the interest of the consumer by regulation of prices, and to judge from the facts of experience in the regulation of transportation of other public utilities, the public coal commissions will be given sufficient discretionary powers to safeguard the interests of producer and consumer alike, and even mandatory requirements, either legislative or executive, will be subject to judicial review.

Competition seems to have failed of late years to benefit the consumer of coal. In the bituminous fields the competition whenever present has been wasteful, and in the anthracite fields there has been practical absence of healthy competition, and whether too great or too little competition, the result is the same—to increase the actual cost of bituminous coal by saddling the industry and its product with the fixed charges on idle or semi-idle mines, and to raise the price of anthra-

cite coal by favoring the burdens of high resource costs.

In estimating the aggregate losses incurred by society by reason of the large number of mines not working at full capacity, the facts to be considered are that the capital invested in mine equipment asks a wage based on a year of 365 days of twenty-four hours, while labor's year averaged last year only 230 days in the anthracite mines and only 203 days in the bituminous mines with only five to eight hours to the day.

As coal is more an interstate than intrastate commodity, any regulation of prices needs to be under federal control, and to benefit both consumer and producer such control cannot stop with transportation and mining costs, but must stand ready to exercise full rights as a trustee of the people over the coal in the ground. The private owner of coal land, which derives its real value from society's needs, has no more sacred right to decide whether or not that coal shall be mined when it is needed by society or to fix an exorbitant price on this indispensable national resource than the coal operators have to combine for the purpose of exacting an excessive profit from the consumer, or the railroads to charge all that the traffic may bear. The proposal to bring landowner under the same rule as mine operator and coal carrier may seem radical, but where is the point at which coal becomes the resource upon which industrial society depends for its very life?

Public regulation, however, will be fair, and, indeed, in the long run will prove beneficial to the landowner as well as to the consumer, to the mine worker as well as to the operator, because any such agency as the Federal Trade Commission, in its control of prices, must determine costs; and as we interpret the present attitude of the whole coal-mining industry, the operators are willing to rest their case on a fair determination of actual costs on which their profits may then be figured.

U. S. Geological Survey,
Washington, D. C.

Recent Development in Incandescent Gas Mantles*

By E. L. Knoedler

General Superintendent The Welsbach Company

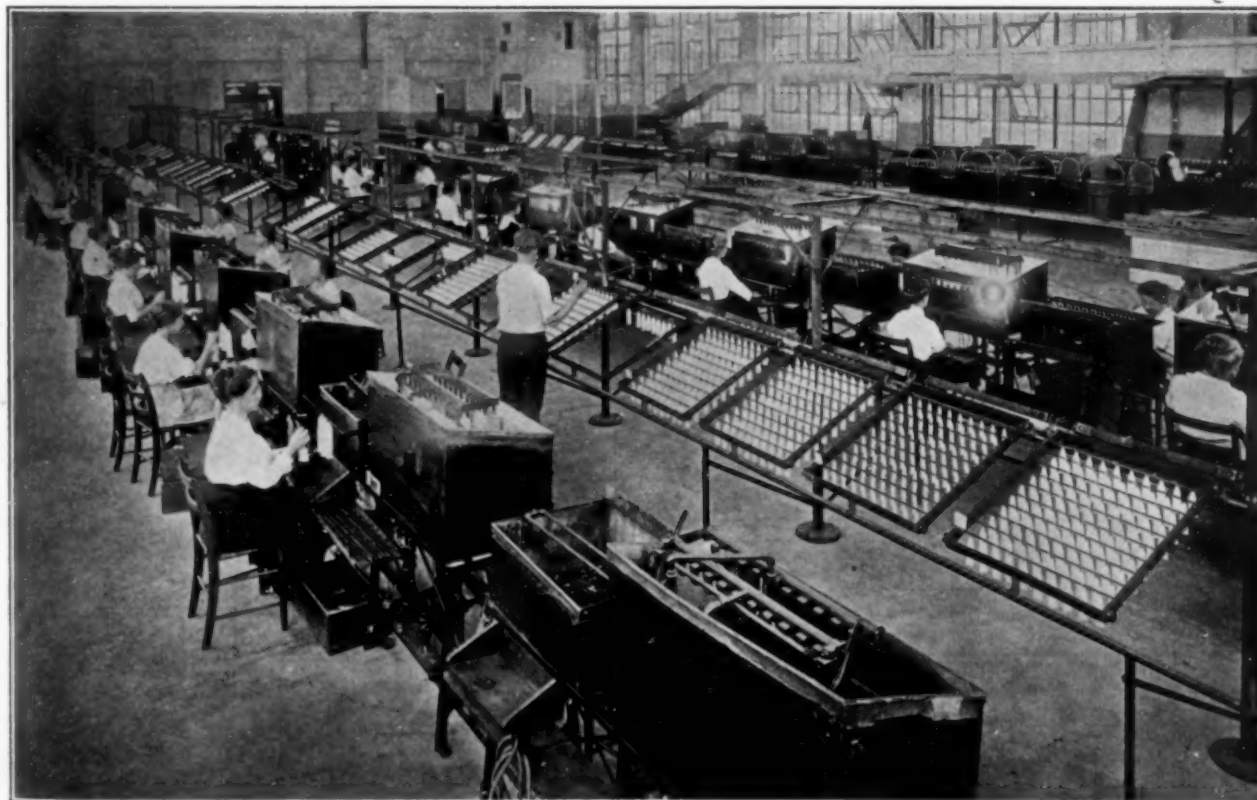
Much has been said and written about the process of manufacture of gas mantles, so much, in fact, that I have feared the possibility of presenting much matter that is already familiar to you.

The flexible mantle or rag mantle is not new to those who are acquainted either with pressure gas or with pressure gasoline lighting. To be sure, pressure-gas lighting has been very slow in developing in the United States, but in Europe it finds wide and successful application. On the other hand, gasoline pressure lamps using rag mantles are very numerous and popular in this country, particularly in the great Northwest.

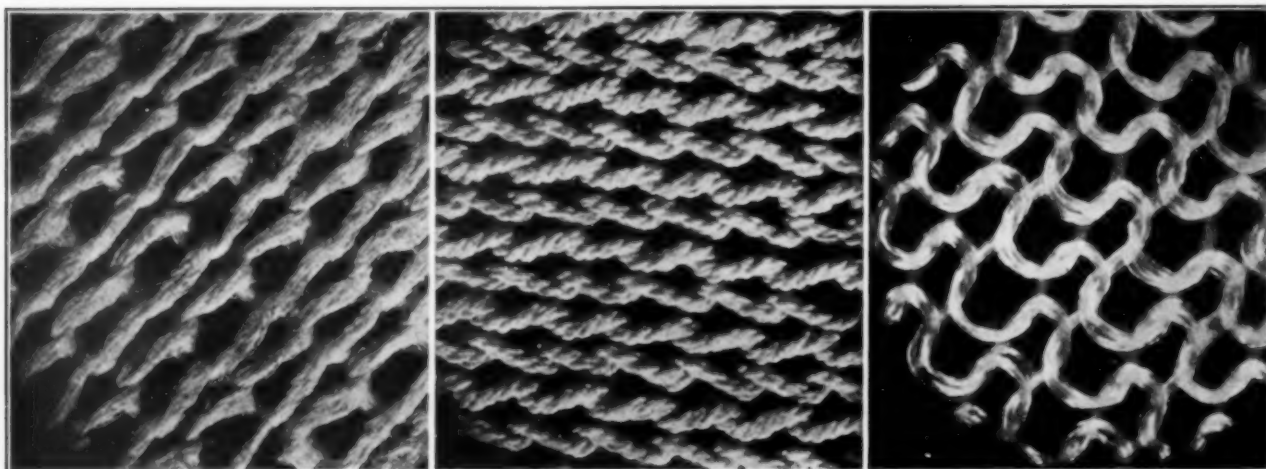
From time to time statements have been made and lurid advertisements have appeared, announcing successful flexible mantles for use on ordinary gas burners, but as a matter of fact these statements have been largely those of fakirs, whose wares have been advertised and exploited as "unbreakable mantles." During the past few years, first one, then another, of these mantles has appeared, only to disappear again as does every article which fails to impress the consuming public as measuring up to the claims made for it.

An important point in connection with the use of a flexible mantle is the fact that the mantle is only partially manufactured. The customer purchases an unfinished article and assumes the risk of carrying out successfully that part of the technical manufacturing process which the maker of the goods has permitted him to assume. These risks of damage and loss vary inversely as the quality of the article. In order to be successful and satisfactory, the advantages of using a

*A paper presented at the joint meeting of the New York Section of the American Electrochemical Society and the Illuminating Engineering Society on Nov. 9, 1916.



THE BURNING AND HARDENING OF THE UPRIGHT TYPE GAS MANTLES



RAMIE MANTLE FABRIC. NOTE PARTICULARLY THE IRREGULARITY OF FIBERS AND FABRIC

COTTON MANTLE FABRIC. NOTICE ABSENCE OF INDIVIDUAL FIBERS

ARTIFICIAL SILK MANTLE FABRIC. NOTE THE SMOOTH, PLIABLE, UNIFORM FIBERS

flexible mantle must outweigh the disadvantage and the trouble to which the customer is put, when he is compelled to perform the later manufacturing operations himself, at the time of putting the mantle into service.

Now, these much advertised "unbreakable" mantles, of which I have made mention, have been without exception the very cheapest and flimsiest which could be made and still hold together until in place on the burner. No other construction would permit of sufficient expansion by the flame of the ordinary gas burner to produce even the remotest resemblance to a gas mantle.

The use of medium-grade, or more often of low-grade cotton or ramie threads, impregnated with only the smallest possible quantity of thoria, has resulted in such a weakened structure that the mantles soon fell to pieces.

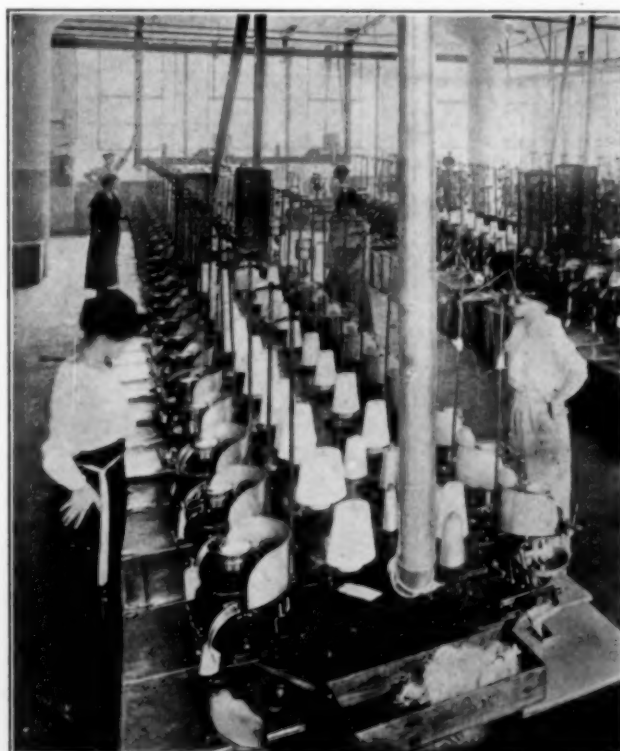
Again, as a rule, the shape of these mantles has not been favorable to the production of maximum candle-power.

Finally, if the shape of the mantle was satisfactory, and if by chance it was able to remain in service for any length of time, the candle-power was found to deteriorate very quickly and the color to change from yellow to greenish white, after burning only a relatively short time. These changes were due in large measure to the poor quality of the base or to the small quantity of light-producing materials present.

In the case of the new mantle of which I shall speak, the shaping or hardening process has been greatly simplified, and the use of an improved base material has almost entirely eliminated the danger to the consumer of a manufacturing loss. This new mantle is unique in a number of ways, but its success depends primarily upon two things: First, upon the fact that it can be

used only upon a burner designed and constructed for this particular mantle. Second, upon the construction of the mantle itself and the character of the materials used in its manufacture.

In connection with the question of the burner I shall only stop to say that the design is such as to produce a perfect gas and air mixture, with any gas at the gas pressures ordinarily available; a mixture which is uniform and which does not contain the lean and fat streaks so often present in gas mixtures provided by the average burner. The flame produced by this burner is very hot, containing more primary air than usual and therefore requiring less secondary air for complete combustion. This makes for perfect combustion with almost complete absence of the tendency to carbonize. This burner has a wide operating range and will permit of considerable over and under adjustment.



KNITTING MANTLE FABRICS

Comparative Physical Strength of Upright Mantles		
	Shock Strength	Tensile Strength
Art Silk	————— *1000 bumps	————— 50000
6 Ply Cotton	————— 427 bumps	————— 329 C.C.
Ramie	————— 250 bumps	————— 321 C.C.
2 Ply Cotton	————— 87 bumps	————— 25.3 C.C.

* Mantles not subject to more than 1000 bumps.



THE SEWING AND INSPECTING OF GAS MANTLES

It will likewise continue to operate satisfactorily when the gas pressures vary so as to seriously affect the majority of other gas lighting burners.

The mantle itself is unique in many ways.

In the first place, it is made from artificial fiber, popularly known as artificial silk.

In the second place, it is small in size, being only $\frac{3}{4}$ in. in length and $\frac{1}{4}$ in. in diameter.

Finally it is of the totally closed variety, having no vent at the top, as have all the older types of both upright and inverted mantles.

First we will consider the material from which the mantle fabric is woven.

Artificial fibers are made by treating cotton or other cellulose fibers in such a way as to convert them into a thick viscous liquid which is forced, under high pressure, through fine dies, into a solution which fixes the thin wire-like strands thus formed.

There are several satisfactory methods for making these artificial fibers, but the best product from the

standpoint of the mantle industry is made by the viscose process.

These fine artificial threads have important advantages over natural fibers, for mantle-making purposes.

In the first place, the physical and chemical properties are almost completely under control, so that fabrics made from artificial threads are incomparably more uniform in their essential physical and chemical features than are those made from the natural fibers.

Again, the artificial thread used, while thin, is very strong and is capable of substantially heavier impregnation than either cotton or ramie threads, which makes for great physical strength and elasticity.

Cotton fiber varies from 1 in. to $1\frac{1}{2}$ in. in length, and is tubular in form.

Ramie fiber, also largely used in the manufacture of mantles, is several inches in length and flattened or husk shaped.

Both of these fibers are more or less hollow, and are



BURNING AND HARDENING INVERTED TYPE GAS MANTLES

often distorted in shape, broken, or otherwise imperfect.

Contrast with these the artificial fiber, of almost infinite length, solid like a wire, uniform in cross section, and of predetermined diameter, in fact made to suit the purpose to which it is to be put, and it is easy to see why there should be a difference in the finished products made from such different raw materials.

Again, the chemical properties of the fibers are of utmost importance in connection with the quality of the goods. The chemical constituents of the natural fibers vary with the different staples, with the character of the ground upon which they grow and with the methods of working in the various mills where the threads are spun and bleached.

These variations render necessary very comprehensive bleaching and washing processes in order that the chemical differences may be so leveled down as to produce a uniform product.

In the case of the artificial fiber many of the chemical impurities have been removed during the manufacturing process, and those which remain have been uniformly distributed throughout the whole batch of material so that all the fibers are of identically the same chemical composition.

In one case we have to work with the natural fibers as nature gives them to us, in the other we deal with a material which can be so fashioned by a controllable manufacturing process as to give us exactly the kind of material we require.

In considering the bearing of these facts, it must be born in mind that the process of manufacture of any gas mantle is essentially that of replacing the fiber with the salts of the rare earths and that the mantle is therefore an exact reproduction in rare earth oxides of what the fiber was.

With these facts in mind, let us examine mantles made from these various natural and artificial fibers, and compare their characteristics.

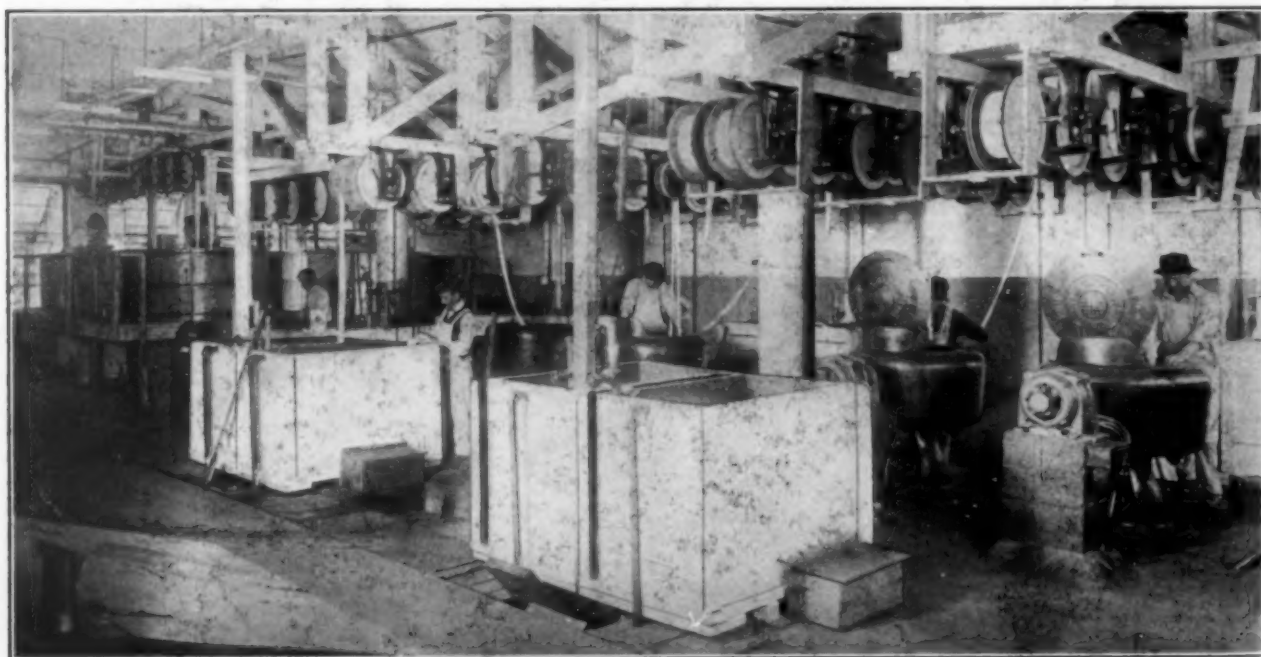
The Cotton Mantle. Soft and flexible initially, after a few hours of burning it will be observed that the mantle is growing hard and brittle. This condition is exaggerated as the period of service lengthens out.

After some time the mantle becomes very hard and is rather easily broken by shock. This change in temper is accompanied by a shrinkage in size, which may reduce the area of the working surface as much as 10 per cent or 15 per cent in 100 hours. As the surface grows smaller, it grows proportionately denser, and less effective as a light-producing body. The openings between the meshes of the mantle structure are reduced in size and the discharge of the products of combustion through the mantle becomes increasingly difficult. Gradually the air inflow is throttled and combustion becomes less and less perfect, resulting finally in the worst cases in carbonization and breakage of the mantle. In any case, these changes in the cotton mantle produce a substantial drop in the candle-power during the first 50 or 100 hours of service, with a further slow but certain reduction as the mantle continues in use.

Finally, not only has the amount of light been considerably reduced, but the color of the light has changed from an agreeable mellow color to a greenish white. These phenomena take place in every cotton mantle in a shorter or longer period of time, but they proceed with special rapidity in a mantle which has been skimmed during manufacture either by the use of inferior cotton, or by improper density of impregnation.

The Ramie Mantle. Ramie mantles are initially flexible, like cotton mantles, although somewhat harder in texture. Like cotton mantles, they also change on burning, from a flexible structure to one which is hard and brittle. If anything, the ramie mantle becomes more brittle and less able to withstand the shocks to which it is subjected in service, than does the cotton mantle. While in the matter of physical strength the ramie mantle is thus much like its predecessor the cotton mantle, in the matter of shrinkage it is greatly superior. For this reason it has become very popular when made in the inverted style. On this type of burner shrinkage of the mantle is a particularly serious matter, as small derangements in adjustment are likely to cause carbonization and mantle breakage.

The candle-power life of the ramie mantle, like the shrinkage, shows great improvement over the cotton mantle, but the results are not all that are desired.



WASHING DEPARTMENT, WHERE THE THREADS ARE CLEANSED OF THEIR IMPURITIES BEFORE BEING MADE INTO GAS MANTLES

It is characteristic of both these mantles that the fine filaments which cover their working surfaces pick up and hold the mineral dust which is drawn into the burner with the air supply. This dusting of the incandescent filaments with siliceous matter probably contributes materially in hastening the depreciation of the mantles.

The color of the ramie mantle also changes slowly as the mantle continues in service.

The Artificial Fiber Mantle. Artificial fiber mantles in service appear to undergo no change in physical condition, maintaining their strength and elasticity over long periods of time. They never become hard and brittle and their ability to withstand shocks after a long life of service seems to be almost as great as it was initially.

The physical strength of these artificial mantles is surprising; they will withstand many times the amount of rough treatment required to destroy the best cotton or ramie mantle. They do not shrink in the slightest degree even after many hundreds of hours in use, but remain perfect in shape, and adapted to the flames to which they have been adjusted.

One of the most remarkable features about the artificial silk mantle is the fact that during the first few hundred hours the candle-power actually shows an increase, which often amounts to 5 or 6 per cent; following this there is a very slow depreciation of candle-power, but even after 1000 hours of service it will usually be found that the mantle is giving as much light as it gave in its initial test.

The color of the light given by silk mantles is likewise very stable in its quality, the change in color being almost imperceptible even after long periods of use.

These several features so favorable to the use of artificial silk in the manufacture of gas mantles, have made possible the development of a successful limp or rag mantle.

We have observed that light weight is necessary if the limp mantle is to be properly shaped on the low pressure gas burner, but light weight in a gas mantle is not compatible with either strength or sustained candle-power. Here artificial silk supplies the deficiencies. These fibers, even though made very fine and light, are yet, by the nature of their structure, able to impart great strength to the mantle. The use of many such very fine fibers gives a working surface of large area, hence high candle-power. Sustained candle-power and the absence of shrinkage complete the list of features necessary to a high grade and successful article.

Up to the present time it has been found most practicable to make this new mantle in a relatively small size, and to so construct the burner that it takes three mantles instead of one. This has several important advantages, one of which is the fact that the small mantle is light in weight and small in area and, therefore, much stronger proportionately than it would be if of larger size. The shortening of the mantle greatly reduces the liability of breakage around the ring, as it not only reduces the load carried by that part of the mantle which is tied fast to the ring, but it also minimizes the tendency of the mantle to whip off from its solid fastening.

The proper shaping of this mantle on the burner takes place with greater certainty than it would if the mantle were of larger size. This point will be seen to be of importance, when it is remembered that the shaping is not carried out in the factory at the hands of an expert, but that every customer must do this work for himself.

The maintenance man who must carry and handle

large numbers of mantles in the course of a day's work will especially welcome this change in size.

The use of three mantles on a burner instead of one has the advantage that if one mantle is broken the lamp does not go out of commission, but still continues to give a large amount of light.

As we observed before, this mantle is of the totally closed variety, there being no vent at the top through which a portion of the gases may escape. All the burning gases must pass through the mantle and be effectively utilized in the production of light. The mantle holder itself is threaded and screws tightly on to the burner nozzle, an advantage where there is vibration.

These new mantles are uniformly and brilliantly illuminated over their entire surface, even in the zone immediately adjacent to the mantle ring. Their intrinsic brilliancy is higher than that of any low-pressure mantle heretofore developed and from the results so far tabulated their useful life appears to be greater than that of any other gas mantle in common use to-day.

Some Notes on Gas Standards*

By W. R. Addicks

Vice-president Consolidated Gas Co.

The title of my remarks might more appropriately read, "Some Notes on Gas Standards and Their Influence on the Prosperity of the Gas Industry."

At no time in the history of the gas industry has the business future of this important public service commodity seemed so bright as now.

The most important requirement for good gas service is *uniform quality*. For reasons that will appear this is becoming possible through the introduction of the heat-unit standard for gas quality. Taking as a basis gas made by carbonization of bituminous coal, that is, coal gas, we have available two diluents, first water gas having about 325 heat units per cubic foot, and second, oil gas with about 1200 heat units per cubic foot. With these two sources available for equalizers, coal gas, whether made by the coke oven process or by the retort process, either horizontal, inclined or vertical systems, may be successfully controlled in spite of the tremendous variations in demand due to atmospheric and seasonal causes, as well as because of the range of sales due to occupational conditions on Sundays, weekdays and holidays. In large companies the variation in output from day to day may frequently reach 10,000,000 cu. ft., or an amount equal to the maximum daily demand of a city of several hundred thousand inhabitants, as, for instance, the city of Boston, excluding its suburbs.

The next most important requirement for good gas service is *constant pressure*. This does not necessitate uniform pressure in all areas. It is only necessary that the changes in pressure in any one locality shall not have too wide a range, the amount of pressure at any point not being the essential element. Here again a heat-unit standard for quality is of great service, for high-pressure mains may be introduced, where desirable, that will effect this pressure equalization without material deterioration in heat-unit gas quality. In suburban communities high pressure is now common in the house services of the distribution system; house governors reduce the initial pressure to any required point, and escape pipes are installed to provide for any derangement of the governor. A high-pressure system is impossible under a candle-power requirement for quality.

*A paper read at the joint meeting of the New York Sections of the American Electrochemical Society and the Illuminating Engineering Society on Nov. 9, 1916.

In addition to standards for gas quality and pressure of distribution, we have standards for purity relating to sulphuretted hydrogen, fixed sulphur compounds and ammonia, and standards for accuracy in metered service.

It is not proposed to go into any historical outline of the progress of the gas industry or to trace the successive regulatory requirements for gas distribution, but it is appropriate to cite some inventions during the past 100 years or more that have rendered possible the present prosperous conditions in the gas industry. Some of these are the hydraulic seal; the steam boiler and engine; the gas exhauster; the gas holder (formerly known as the gasometer); the gas meter; the photometer; the gas cooking range; the internal combustion engine; the many types of industrial appliances; the fireclay retort, which displaced the cast-iron retort, thus enabling the manufacturer to increase the gas yields from coal, and the later highly refractory silicate materials for both retorts and settings, which permit still further increase in gas yields per pound of coal; apparatus for gas analysis, readily operated by others than chemists; the calorimeter and surface combustion.

There have appeared from time to time epoch-making influences in the history of the gas industry since 1792, when Murdock introduced gas for lighting. Some have been apparent at the time, while others are appreciated only after a lapse of years, during which their influence has been at work.

The introduction of cast-iron pipe about 1808 for distribution purposes greatly aided in making the gas industry permanently successful. Cast-iron mains seldom require renewal except because of obsolescence due to existing mains being too small for the demands of modern industry.

The use of regenerative methods of heating gas retorts by Siemens about 1862 resulted in a material advance in manufacturing methods.

The successful carburization of blue water gas by Professor Lowe and his contemporaries about 1875 not only increased the use of gas because of low cost while oil was cheap, but made it possible to meet commercially the varying demands from day to day with plant costing less per unit capacity capable of operation to full capacity at an hour's notice with but a fraction of the idle labor coal gas manufacture then required, notwithstanding the aid of large holder capacity.

The introduction of electric lighting about 1882, which at first frightened gas investors, later stimulated the gas manufacturer to make marked improvements in processes and methods of manufacture and utilization.

The introduction of the gas mantle burner about 1887, which saved the day for the gas companies by enabling them to hold their lighting business against electric competition while they were building up power and heating business more than offsetting their later losses in lighting due to the remarkable improvements in the efficiency of the incandescent electric lamp developed by the brilliant minds of this new and lusty competitor to the older industry.

The introduction of wrought-iron gas mains intended for high-pressure gas distribution was made by Flannery in 1889. The importance of this innovation was not at once grasped. Later steel pipes with screw or welded joints were adopted for pressure up to 100 lb. per square inch. Many communities now have a gas supply through this instrumentality that would never otherwise have had gas, for it is not possible to supply high-pressure gas under a candle-power standard.

The introduction of the automobile in 1891, where an internal combustion engine used gasoline for power, revolutionized the water-gas industry. All water-gas

plants habitually used gasoline and naphtha for enriching. These were entirely withdrawn from the market for this purpose, resulting in the abandonment of some gas plants that prior to this time were justly celebrated for the gas product produced. Fortunately the Lowe type of water-gas apparatus successfully utilized a lower-gravity petroleum, later known as gas oil, and this branch of the industry survived the crisis. Contemplation of this condition impels me to remark that this generation is using for its pleasures the necessities of future generations; it is to be hoped that the future generations may offset this serious condition by new inventions that will neutralize our prodigality.

The introduction in this country of by-product coke ovens in 1879 to 1893 has resulted in what may properly be styled by-product gas. In this coke process 5 to 12 or more tons of coal are heated with gas in an oven for eighteen to twenty-four hours, whereas in gas manufacture but 1000 lb. of coal is heated with coke in a gas retort for periods ranging from four to six hours. Probably in the future, producers using coke will supply the heat for coke ovens, in which case all the gas from the coal will be saved for other industrial uses in place of but 40 to 60 per cent as at present. As the success of the coke oven depends upon a uniform demand for coke in very large quantities, the gas, tar, and ammonia are by-products; coke ovens are not used by the gas manufacturer, for with him gas must be the chief product, and coke, tar, and ammonia by-products. Some gas companies purchase by-product gas for their general distribution, but they are compelled to maintain water-gas plants in order to supply immediately the gas demand when the coke oven plants are compelled to decrease their output because of dull coke markets or other reasons, climatic or commercial.

Continental Europe and Great Britain now have heat-unit standards for gas quality, and in the year 1915 the Dominion of Canada has followed Great Britain's lead. New Hampshire, New York (Second District after Jan. 1, 1917), Connecticut, Pennsylvania, New Jersey, Maryland, and the District of Columbia, and many other States of the Union are now using heat-unit standards for quality. At the last annual meeting of the American Gas Institute the following resolutions were adopted:

"Resolved, That the total heating value in manufactured gas best represents its quality for standard requirements, and

"Further Resolved, That the American Gas Institute recommends the adoption of the total heating value as the only standard basis of rating the quality of all manufactured gas distributed in the United States."

The Institute further adopted the following:

"Experience has demonstrated that in establishing any definite calorific standard for gas, the following are conditions that govern:

"1. In any calendar month gas should on the average at least meet the standard fixed.

"2. Except in case of accident or other incident of manufacture reasonably beyond control, the average of any day's determinations should not fall below the standard fixed by more than 10 per cent.

"3. Where gas is compressed the heating value shall be determined before compression.

"4. Gas should not be required to contain such percentages of constituents as to render the gas unstable under varying conditions of atmospheric temperatures and pressures.

"5. The standard adopted should not unnecessarily restrict the use of materials or processes to the detriment of economical manufacture or to prevent the conservation of natural resources.

"6. Materials and processes may be used whose by-products of manufacture are of military value to the Government."

In the future gas standards will undoubtedly provide for a total heating value, and absence of sulphuretted hydrogen and a limitation in distribution pressure variation at the meter. All fixed sulphur, ammonia, maximum and minimum distribution pressures and candle-power limitations will be abandoned as obsolete under modern conditions.

The adoption of a proper heat-unit standard improved measurably the strategic position which gas holds in the illuminating field. Distant control of the electric lamp has been the most important influence that has aided electricity to take the lead of gas in general illumination. Through the adoption of a heat-unit standard that no longer requires that gas contain constituents that tend to produce the deposition of carbon when burning will permit pilot lights and gas mantles, as well as water heaters and domestic utensils, to become more efficient due to greater ease in permanent regulation of gas combustion and a uniform cleanly condition, not depreciated by carbon deposit that climatic temperature changes surely bring about when the manufacturer is endeavoring to follow a candle-power standard. Candle-power standard gas, subject to severe atmospheric conditions, may lose in effectiveness 30 per cent where a heat-unit standard gas may not vary 2 per cent.

Where there is a gas supply and no central station electric service is available, it will be found very much easier and cheaper than formerly to obtain electric illumination through the use of the gas engine and electric generator. The gas engine is now a comparatively simple piece of machinery to a large number of persons, including many women and young men, because of their familiarity with automobile engines. The modern electric lamp of 50 cp. now requires but 50 watts of electric energy, whereas not many years ago it required four times that energy. A 5-brake-horsepower gas engine will now produce power for nearly seventy such lamps, while formerly a 20-hp. engine would have been required. The capital required for the installation and the difference in the yearly charges for gas, water, interest, depreciation and repairs of a 5-hp. engine when compared with a 20-hp. engine is very considerable. When using a 5-hp. engine no additional gas service would be required from the gas supply main, where the premises are already supplied with gas service. Should further improvement be made in electric lamp efficiencies, then more lamps, and hence a larger establishment, could be maintained with the same gas-engine equipment.

The gas mantle will always insure to the gas companies a large share of the illuminating business; as candles still continue to be used, so flat-flame burners will doubtless be used in cellars and furnace rooms; gas can be depended upon without the mantle burner for light sufficient for such purposes, but the use of the flat-flame burner for illuminating purposes with any gas is wasteful in the extreme. Great advance has been made in the adaptability of the mantle burner to the multitude of conditions that an illuminating burner must fulfill in these days. In this connection attention is directed to an article entitled "Gas Lighting in Industrial Plants," by Mr. Thomas Scofield, which appears in the *Engineering Magazine* for October, 1916. As gas pressures increase, the efficiency and general adaptability of the mantle burner will increase. As an illustration, I would recall to your mind the beautiful high-pressure lighting at the World's Fair in San Francisco in 1915.

It is most fortunate that the commercial conditions that make a heat-unit value for gas quality imperative should at the same time improve and simplify all problems of distribution and likewise that any increase in distribution pressures should under such a standard improve efficiency in the utilization of gas. These influences will doubtless be felt most beneficially in gas illumination through the use of the gas mantle. As hereinbefore stated, this invention has had a most important influence on the success of the gas industry in the illuminating field, and I believe it will hold its own against all competitors in the future.

Hollinger Consolidated Gold Mines Limited.—For four weeks ending Sept. 8, 1916, the milling costs of the Hollinger Consolidated Gold Mines, Ltd., was \$0.927 per ton. The mill ran 90.4 per cent of the possible running time, treating 50,177 tons. The average value of the ore treated was 8.59 per ton.

New Tannery in Norway.—A new establishment for the preparation of tanning extracts will be erected in the vicinity of Bergen, Norway, and will start operations in about one year. The name of the company is Den Norske Garveextractfabrik and is capitalized between \$200,000 and \$400,000.

Gold Production in British South Africa.—During the period from September, 1913, to January, 1916, the Transvaal production of gold was at the rate of \$194,660,000 per year. The average grade of ore treated was 8 cents lower, while the working costs increased from \$4.20 to \$4.28 per ton milled. In February last the milling cost rose to \$4.50 per ton. The working costs of the industry, amounting to \$121,662,500 remained largely in the country. Although the working profit per ton showed a decrease of 16 cents, the total working profit was higher than that for 1914 by \$1,006,251. The ratio of the Transvaal output to the world's total output for the year 1915 was 40 per cent, as compared to 38 per cent for 1914. The 1915 output represented 67 per cent of the gold production of the British Empire.

Extraction of Kauri Gum Oil in New Zealand.—In the northern part of New Zealand are found large beds of peat carrying fine kauri gum particles, and which are rich in materials producing kauri gum oil. It is claimed that the peat yields 20 to 30 gallons of oil per ton, of which about 25 per cent resembles gasoline or benzine. The remainder contains twenty-eight different kinds of heavy oils, several of which make good varnishing material. A company has been organized to extract from these peat beds the kauri gum and the kauri gum oils.

British Dyes, Ltd., held the first annual meeting at Huddersfield, England, on Oct. 12. The subscribed capital of the company and the loan capital to which they were entitled from the Government represented at the meeting held last year about \$7,350,000. At the close of the year ending April 30th, 1916, the capital had increased by about \$1,650,000, and at present the total capital is about \$9,600,000. One of the most important matters occupying the attention of the board was the supply of indigo. The only company producing indigo before the war was at Ellesmere Port, formerly owned by Meister, Lucius and Brüning. This plant was taken over by Messrs. Levinstein, Ltd., after the Board of Trade had decided not to let British Dyes, Ltd., bid for it. The chairman said that the company was devoting its main energies to the construction of plants and the carrying on of research necessary to manufacture the intermediates. A dividend of 6 per cent was ordered paid.

The Chemical and Physical Properties of Foundry Irons

By J. E. Johnson, Jr.

(Continued from page 597)

The Less Common Alloying Elements

CHROMIUM

The effect of chromium on iron and iron-carbon compounds has also been extensively investigated by Sir Robert Hadfield.¹ The effect of chromium is to harden the matrix of the iron, making an intensely hard but very brittle double carbide of chromium and iron. In low carbon alloys this makes a very strong, hard steel of low elongation. When the metal contains enough carbon to constitute cast iron, the tendency is to throw more and more of it into the combined condition, until, at 3.0 or 4.0 per cent chromium, the metal is entirely white, the fracture being flat, shining, highly polished plates, very similar to those in *spiegel*, and to those of weak iron carbon eutectic previously illustrated. (Compare Fig. 35, showing chromiferous iron, with Figs. 3 and 4, showing weak, high carbon, spotted iron.)

There is no doubt that chromium strengthens iron by throwing the carbon into the combined condition and by closing up its grain. It enables a hard chill to be secured, even in spite of the influence of a considerable percentage of silicon; but the structure consisting of these laminated plates has not the staying power of a chill produced by oxygen content without any other substance.

Fig. 36 shows a strong charcoal iron remelted in a crucible with sufficient chromium to raise the content of the remelt to 4 per cent. The structure to which I have alluded is strikingly shown. Test bars made from this mixture were strong, but not by 20 per cent as strong as test bars made from high oxygen iron without such a mixture. Chromiferous iron, particularly a

¹Journal of the Iron and Steel Institute, 1892, vol. II.



FIG. 35—ETCHED (MAGNIFIED 100 DIAMETERS) CHROMIFEROUS PIG IRON. NOTE SIMILARITY TO EUTECTIC STRUCTURE OF (MESH) SPOTTED IRON, FIGS. 3 AND 4 (PAGE 534)

natural alloy made from certain ores, which contain chromium and nickel to the extent of about 2.5 and 1.25 per cent respectively, has been urged, in the past, as a substitute for the best grades of charcoal iron. It has only been moderately successful, however, in meeting the claims made for it. It would seem that it is impossible for this alloy to equal the product which I shall presently describe, since this product is far superior in quality to charcoal iron.

NICKEL

Nickel seems to be one of the few metallic elements which produces a truly beneficial effect on the character of cast iron. Its highly beneficial effect on steel has long been understood, but this effect does not begin until the amount of nickel exceeds 3.0 per cent. Beneficial results are derived by its presence in cast iron to the extent of only 1.0 or 2.0 per cent. It strengthens the iron and improves its chilling power, without appearing to cause any lamination or other objectionable features. These statements are based solely upon some experience made at Ashland by remelting irons in the crucible with nickel sufficient to give the above-mentioned percentages, and it would be unwise to generalize too widely on such limited data.

It is, of course, not to be overlooked that the expense of nickel for treating cast iron is almost prohibitive. One per cent, or 22 lb., would increase the cost about \$7 per ton, and that consideration, taken in conjunction with the fact that even nickel is not able to produce results as good as those obtainable with the new kind of iron presently to be described, makes this an unprofitable field for further research.

For strong, tough irons with hard, wear-resisting chill, no material has apparently been developed as good as an iron containing as much oxygen as its silicon content will permit.

TITANIUM

The effect of titanium on cast iron is a much-discussed question, and not nearly so much experience is available



FIG. 36—ETCHED (MAGNIFIED 100 DIAMETERS) PIG IRON WITH 4 PER CENT CHROMIUM. NOTE FLAT CRYSTALS AND COMPARE WITH FIGS. 3 AND 4 "SPOTTED" POOR CHARCOAL IRON

for the solution of it as in the case of manganese, but the probabilities are that the action of this alloy has also very contradictory effects, on account of its action on different elements.

An extensive paper on the subject was published by Prof. Bradley Stoughton before the American Institute of Mining Engineers in 1912, but the results recorded as to the effect of strength of cast iron, etc., were rather contradictory. One thing, however, seemed to stand out very clearly, and this was that titanium reduced the chill. This is in accordance with what we should expect, for titanium is one of the strongest deoxidizers known. It also has a very high affinity for sulphur and nitrogen. Such effect as nitrogen has is undoubtedly in the direction of producing chill, and therefore, the effect of titanium would tend to remove three elements producing chill, namely, oxygen, sulphur, and nitrogen. This amply explains why the chill is reduced, and probably explains also why the results on strength are so contradictory. The titanium removes the highly beneficial oxygen, and it also helps to remove the detrimental sulphur.

The reduction of chilling power which is admitted by advocates of the use of this alloy for cast iron requires the use of more manganese for its restoration, and this is highly objectionable, for reasons already pointed out, and it seems extremely doubtful that any benefit will be found by prolonged experience to result from the use of titanium in cast iron, even in spite of the fact that its action on the matrix of the iron itself may be to strengthen it. Its influence in removing oxygen in good castings is extremely detrimental, and this is probably not offset by any other beneficent action which it may have, while where particularly good castings are not required there is no call for the use of any treating material whatever.

VANADIUM

Following the general custom of claiming a beneficial action on cast iron for any alloying material which has been found useful in steel manufacture, traces of vanadium have been claimed to have a beneficial effect on cast iron. Vanadium, like titanium, is a powerful scavenger. Its best-informed advocates claim that its principal service is not in remaining in the steel itself, but in going out of it with the oxygen, nitrogen, etc., which it removes.

This is exactly the same effect as that produced by titanium, and it seems almost certain that vanadium will be found objectionable in good irons containing oxygen, as it has already been found to be without benefit for ordinary castings not containing that element.

Great claims have recently been made for irons containing traces of this element, but the photomicrographs used to illustrate the claims did not display a particularly meritorious structure, and the results of the physical tests given were so far below the results obtainable with irons containing oxygen as to be beneath comparison with them.

As a result of this review of all the metals that are claimed to benefit cast iron, we see that most of them, with the possible exception of manganese, have based their principal claims on being deoxidizers, although some also have merit as desulphurizers, and some have a direct effect in throwing the carbon into the combined condition.

We have already seen, and I trust that I shall be able to show still more clearly presently, that oxygen is of greater benefit to cast iron than any other element at our disposal, with the exception of silicon, and that any addition to the iron which tends to remove oxygen is not beneficial to it, but is highly objectionable, the accepted theories to the contrary notwithstanding.

We have seen, by unmistakable evidence also, that, while some of these metals tend to throw the carbon into the combined condition, the form into which they throw it (or rather the type of crystallization which they induce) is an extremely objectionable one, being inherently weak and brittle, and that the sole benefit which we can expect from the use of these metals is the removal of a portion of the sulphur, for which a small amount of manganese seems to suffice—at least to the extent to which such removal is possible. When this result is accomplished with manganese in moderation, the strength of the iron is not materially impaired, though its chilling power, in the judgment of some expert users, is decreased after the manganese increases above 0.3 per cent.

It seems safe to say, therefore, that, if it were not for sulphur, the more perfectly we dispensed with any of these alloying metals the better iron we should obtain where strength, close grain, and strong, hard chill are the qualities desired.

Remember now the demonstrated fact that the old-fashioned cold and warm blast charcoal iron contained much oxygen, and you will understand that the conscientious founder, in his insistence on the use of these materials for high-grade chilled castings, was not actuated by prejudice and ignorance, but by a profound knowledge of his subject, even though he could not explain the reason for the results produced.

It will be clearly recognized that this is a flat contradiction of the tenets of theoretical metallurgy, but we find it necessary in every science to recognize, from time to time, the fact that we have taken a wrong trail and are being led from, not toward, our goal, and the only thing to do under such circumstances is to leave that path and take up the correct course, even though we have to retrace our footsteps in doing so.

A critical examination of the basis of the old theory will disclose the fact that the amount of real evidence on which it rested was small. No work of any amount in determining the actual oxygen present in cast iron by the combustion method has ever come to my attention, except that which we initiated at Ashland, and, while some work has been done by solution of the iron and determining the residual oxide, this method cannot receive much consideration on account of the vast possibilities of oxidation during solution.

It is true that there is a vast amount of inferential evidence available to the careful observer that oxygen produces a difference. I was convinced that there was oxygen in some iron ten years before I had obtained any determinations of that element, and the results of the subsequent determinations have shown that I was right, but, because the iron produced was for steel-making purposes, and, when high in oxygen, was generally high in sulphur also (and therefore rejected by the steel works), I considered the effect of oxygen harmful. This was a coke iron, and when I first saw the "special" charcoal iron I condemned it as worthless, because of its strong resemblance to this high oxygen coke iron. The introduction of the testing machine soon showed the complete fallacy of this judgment.

On the other hand, much has been said as to the burning of iron by overheating it, and its poorer quality when overheated has been attributed to the introduction of oxygen, especially in air-furnace work. The explanation will work just as well if turned the other way around. When metal is overheated in the air furnace the oxygen, of which that apparatus introduces a little, reacts with the silicon or carbon, or both, and goes out, weakening the iron and impairing its quality, just as the exponents of the "burning" theory contend.

The fact that increasing temperature promotes the

elimination of oxygen is proved by several facts. The "Experiments on the Overoxidation of Steel" carried on by Messrs. Shimer and Keachline, and reported by them in a paper before the American Institute of Mining Engineers, showed that, as the temperature went up, less oxygen stayed in. These investigators found less oxygen in steel with only about 1.0 per cent carbon and no silicon than we find in cast iron with 3.5 per cent carbon and 1 or 2 per cent silicon, because the temperature of molten steel is some 500 deg. higher than that of cast iron.

In the course of my own experience, I have seen a heat in a small converter purposely blown cold until the silicon was removed, but most of the carbon left in. This metal was alive with oxygen. It was exceedingly "wild" when hot, and when cold it was so full of blowholes as to have no strength whatever. The same iron, blown hot, yielded steel of a very high temperature, containing only about 0.06 per cent carbon, and was absolutely quiet, even before the addition of the deoxidizers, and poured like cream.

All these facts agree with the well-established general law that the affinity of carbon for oxygen increases very rapidly with the temperature. You will see then that, while the view I am offering you is opposed by an accepted theory, it is supported by a vast array of established facts.

In spite of the volume of evidence which we have accumulated, and which I have set forth in the published paper above mentioned, I am well aware that it would be impossible for many to accept my conclusions on this evidence alone. I shall pass, therefore, to the second stage of my subject, namely:

The Production of an Iron High in Oxygen and the Characteristics of Such an Iron

When I had obtained what seemed reasonably valid testimony that oxygen was the cause of the good qualities in charcoal iron, I began to experiment with methods of introducing it at will by different ways of operating the furnace, and also by introducing hot ore, mill scale, etc., into ladles and then filling the ladles with iron as it came from the furnace. This yielded no useful result.

After I had left the charcoal iron business I began to investigate further the conditions under which silicon and carbon were removed from iron during its conversion into steel, in order to obtain a method of introducing oxygen into iron at will without lowering the carbon. I found from the steel men that by starting with a very hot heat in the Bessemer, they could blow the carbon out to a very considerable extent before the silicon was gone, while with a comparatively cold initial heat the silicon would practically all disappear before the carbon began to be removed. Moreover, it seemed perfectly evident that the reason I had been unable to get oxygen into normal irons, either in or outside the furnace, was because, at the temperature at which I was working, the activity of the silicon and that of the carbon were such that they instantly removed the oxygen.

It is, of course, no trouble to resiliconize a bath of metal, and therefore it seemed to me that if I could take metal and reduce it to the condition of the spongy white iron, which we obtained from the furnace when it was so cold as to be almost chilled, and could then mix that with normal iron high enough in silicon to give the resulting mixture the desired silicon contents (all the while keeping the temperature as low as possible), I should reproduce, outside the furnace, the conditions which had existed inside it, always providing that the temperature was kept low enough, because ob-

servation of converter practice had convinced me that 0.05 per cent carbon was more efficacious in removing oxygen at 3000 deg. than was 3 per cent at 2300 deg.

Accordingly, therefore, I had preliminary tests made at a steel-casting plant. A heat of metal of 1.0 per cent silicon was blown in the side blow converter, holding the temperature down by stopping the blow and turning down the heat several times. The blow was continued until the carbon flame began to break through, showing that the silicon was gone and the carbon was beginning to go. The blow was then stopped and the vessel turned down. The sample of metal taken from it at that time was, when cold, a white iron full of blowholes, rotten, brittle, and worthless to the last degree. With this was then mixed an equal volume of 2.0 per cent silicon iron direct from the cupola, and from that mixture test bars were cast. Test bars had also been cast of the original metal, both the 1.0 per cent silicon iron and the 2.0 per cent, and these broke at approximately 2300 lb. on 1 $\frac{1}{4}$ -in. round bars on 12-in. centers. Similar bars from the treated metal broke from 4000 to 4300 lb.

Steps were then taken to obtain patents on this process, and in view of the current opinions in metallurgy, there were but few citations from the Patent Office of anything of a similar nature. On the contrary, the patent examiners found my statements and claims so utterly at variance with all the accepted theories on the subject that they were inclined to consider me a victim of self-delusion. However, we had at hand a mass of evidence, and when it was presented to them they became convinced that, while there was a conflict between the accepted theories of metallurgy and the facts, it would be better to give precedence to the facts, and let the accepted theories go, and they allowed the patents in their broadest possible form.

After this a number of furnace companies were approached, with the view of having them undertake the manufacture of the new metal, and, unless one had experienced it, one would not believe with how little enthusiasm the proposal was received. Finally I went to Mr. E. A. S. Clarke, president of the Lackawanna Steel Company, and he asked me to go to Buffalo to see those in charge of the company's plant there, at the same time accompanying his invitation with intimations of the skepticism of all parties in regard to my process and the results claimed for it. When I reached Buffalo this skepticism was made even more evident and put in more direct language, but when I showed them the experimental results which I had obtained at the steel-casting plant they waived their doubts for the time being, and consented to make a trial of the process.

At the first attempt, the conditions were not altogether favorable. A plant laid out for the production of steel, with no idea of ever desiring to oxygenate pig iron, may obviously not be ideally arranged for the latter purpose, while blowers, familiar with the necessity of getting a high temperature to produce good steel, found it difficult to blow a heat as cold as possible. Moreover, the iron which was used to mix with the blown metal was lower in silicon than we had expected to get, and this resulted practically in a "mottled" iron. All these conditions militated against the success of the trial.

Nevertheless, test bars, made from the metal after treatment, showed an increase of about 20 per cent in strength over the original iron even after remelting, and the Lackawanna Company then felt justified in making another test and arranging the conditions more in accordance with the requirements of the operation. At this second test we provided a metal of about 2.5 per cent silicon to mix with the blown metal. The phos-

phorus was also increased so as to give a result comparable to foundry iron. The metal to be blown was taken from the mixer, and was mixed half-and-half with the high silicon metal, and test bars $1\frac{1}{4}$ in. round and 2 in. square were cast from the mixture to determine the strength of the iron before treatment. After the converterful of mixer metal was blown the high silicon iron was added, and additional test bars were made from this mixture. The $1\frac{1}{4}$ -in. round test bars of the original untreated metal broke at about 3100 lb. average; high silicon metal, and test bars $1\frac{1}{4}$ in. round and 2 in. centers.

Of the treated metal, the $1\frac{1}{4}$ -in. test bars broke at about 5100 lb. average, and the 2-in. square test bars broke at 22,900 lb. average. The $1\frac{1}{4}$ -in. test bars were a little over size in each case, but about the same amount in each, so that the results are comparable. By a curious coincidence, the increase in strength, based on the average of all the good bars, worked out to exactly 70 per cent in both cases. Since that time other heats of other silicon have been made, and the strength is in all cases well above 20,000 lb. on the 2-in. square bar.

The first questions you will naturally ask are: Does the oxygen stay in this iron on remelting, and, if so, why? Why do not the carbon and silicon which are present scour it out, and restore the iron to its normal condition?

The answer to the first is the important one from the commercial point of view, and so soon as we have obtained these results we put some of the iron produced through a cupola as a separate charge. When it came out we raised the silicon with ferro-silicon from 1.26 to about 1.50 per cent so as to make it comparable with ordinary iron from the cupola. Even after this treatment with ferro-silicon, which tended to deoxidize it and also to throw out the carbon into the graphitic condition, the strength remained at 21,000 lb. We had previously demonstrated, by an extensive series of remelts of charcoal iron in crucibles, as described in the paper above mentioned, that the oxygen did remain, and that, as I have already stated, an iron which went into the crucible strong came out of it strong. The actual presence of the oxygen after remelting, as well as before, was determined by analysis before and after the results.

The reply to the second question seems at first sight more difficult, but it is not really so. It seems to be a perfectly general law of chemical action that, while reactions go on in concentrated solutions along certain lines and proceed at least nearly to completion in such solutions, in dilute solutions the same law does not hold. Take, for instance, the case of manganese and sulphur. You know very well that iron sulphide is broken up by manganese; the sulphur is seized and forms manganese sulphide, leaving the iron, and the manganese sulphide then leaves them both. Now, if this reaction proceeded to completion, it should be easy, by adding an excess of manganese, to take out *all* the sulphur. But, as a matter of fact, you are perfectly well aware that this is entirely impossible; that each unit of sulphur is harder to remove than the last; and that you reach a point beyond which the addition of further manganese does not reduce the sulphur at all. I take the same to be the case in regard to oxygen, only that the equilibrium point is lower and the influence of temperature is more important, so that, if the temperature be kept moderate, the oxygen will remain to some extent, unless powerful deoxidizers are added.

In this connection I may say that we had an accidental confirmation of the correctness of the oxygen theory, which may not be without interest. By accident, one heat of the new metal was made with iron

about 3.0 per cent in manganese, so that the resulting mixture contained $1\frac{1}{2}$ per cent. The strength of this iron was reduced 3000 lb.—i.e., from about 21,000 lb. to about 18,000 lb.—on the 2-in. square bar as compared with iron identically the same in all particulars, except that the manganese was normal, or about 0.4 per cent.

There are two other questions of interest:

First.—In what respect and for what reason is this new material better than the so-called semi-steel (cast iron with a mixture of steel scrap)?

Second.—How do we achieve the advantage of high carbon, which, it is my belief, is one of the advantages of cold-blast charcoal iron for special purposes?

The answer to the first may be divided into four portions:

(a) The effect of oxygen is to reduce the graphite to a fraction of its injurious area, by changing its shape. This is obviously far superior to a simple dilution of the carbon, which can only reduce the graphite by about a third in the most extreme case.

(b) The temperature required for the melting of steel scrap is very high, materially above that of an iron with normal carbon. This requires such iron to be raised to a higher temperature than iron with normal carbon, and facilitates the elimination of any oxygen which it may contain.

(c) The use of steel scrap dilutes the carbon and reduces the quantity of cementite which can be formed, so that chilled castings made in this way have not the hardness and wearing qualities of those made of irons with high carbon when the latter is all combined.

(d) It seems certain that carbon in proper condition facilitates the machinability of an iron, remembering that this carbon is in the form of graphite, one of the best lubricants known. It has been demonstrated by experience that an iron of a given strength of matrix machines more easily if it contains more carbon, without necessarily being weaker than low carbon iron if the carbon be in more nodular form than that in the low carbon iron.

The answer to the second question is that, by the hot operation of coke furnaces with a limy slag, the carbon can be forced up to or beyond 4 per cent, and by proper operation in treating it we can preserve practically all this carbon, thereby securing an amount equal to that of the cold-blast iron. Whether we shall be able to go beyond this, and introduce additional carbon during or after the treatment, I am not able to say, because we have made no experiments along that line. It seems likely that this will be unnecessary in practice, for most of the users of cold-blast charcoal iron use it in the air furnaces, and reduce the carbon to between 3.5 and 3 per cent before casting, an amount which we can easily exceed.

We have had a number of tests made by parties who were interested in the purchase of iron. Some of these I am not at liberty to publish, but the representative of one large railroad company has told me privately that it found the strength and chilling power of the iron to be virtually the same as that of one of the famous brands of Eastern charcoal iron. Another railroad company reported that it found the breaking strength of the iron in 2-in. square test bars on 12-in. centers to be 25,000 and some odd pounds; while through the kindness of Mr. Harry B. Swan, of the Cadillac Motor Car Company, I am able to present a table of results of crucible remelts made from this iron.

CADILLAC RESULTS

Analysis	Combined carbon	0.85
	Graphitic carbon	2.65
	Manganese	0.26
	Phosphorus	0.326
	Sulphur	0.039
	Silicon	1.25

The test bars showed the following results from the Standard 1¼-in. round bar of the American Society for Testing Materials, on 12-in. centers (four bars gave the following results):

	A	B	C	D
Transverse strength in pounds.....	4,505	4,825	4,825	4,875
Modulus of rupture, pounds per square inch.....	67,300	67,100	67,100	66,400
Tensile strength, pounds per square inch.....	34,800	33,800	34,100	33,800
Brinell hardness.....	202	207	202	196

Charcoal iron showing above 3000 lb. on the 1¼-in. test bar is strong enough to be put into a class of special iron by itself, while one of 4000 lb. strength is very rare. You will see that this iron is about 60 per cent stronger than the former, and about 20 per cent stronger than the latter. The closeness of its grain you will see from the samples and from the photomicrographs (Figs. 28 to 31). These latter also show the graphite in this iron to be almost completely nodular, rather than of the flake variety, and show, in the most unmistakable manner, why the iron must be stronger than an iron the same matrix, but with wide flakes of graphite. The effects of oxygen in changing the form of crystallization and in preventing the breaking down of the combined carbon are the same in this iron as they are in charcoal iron, except that worm-blast charcoal iron contains only from 0.015 to 0.30 per cent oxygen, whereas we have no difficulty in obtaining 0.050 to 0.70 per cent oxygen, with correspondingly greater effect in these two directions.

The experiments which have been made on actual castings show also that the suppression of the eutectic is more than a scientific hypothesis. One large company found that a certain casting was extremely difficult to make of ordinary iron without having shrinkage cavities along a certain line, but that, when poured from this iron, the castings were absolutely sound at this point. This I believe to be because the iron solidifies all at once as a homogeneous mass instead of passing through a long range of progressive freezing. The last freezing or eutectic portion is that which is altered by the presence of this minute quantity of oxygen into something else with a higher melting-point.

Returning now to the iron-carbon diagram, a valuable suggestion has been made by Professor Campbell, to the effect that there are shown by Fig. 2 several paths along which iron-carbon alloys may pass in cooling; that one of these may result in one structure and another in another, and that the presence of a small quantity of oxygen may be the controlling factor which forces the cooling to take place according to one of these paths or another. This suggestion, combined with the diagrams of Guertler and Upton, goes further to account for the facts as we found them in practice than any other that has been made. The suggestion from Upton, that graphitization occurs on one side of the eutectic point below the eutectic freezing temperature and not on the other, is very much in line with the observations of practice, for it is a fact that certain irons will throw off graphite into the air in great profusion while running from the furnace, whereas other irons of similar composition and perhaps even higher in carbon will show no such tendency whatever. This is particularly true in relatively low carbon coke irons of about 1.0 per cent silicon and relatively high carbon charcoal irons of about the same silicon. The latter scarcely ever makes any show of graphite as it runs from the furnace. The other fills the cast-house until it looks as though a black snow-storm were in progress.

The practical questions may now be asked: Granted that we have here a new material, what is it good for?

The answer is that it is good where strength, closeness of grain, steam tightness, and wearing qualities

are desired. Above all, it is good where chilling power under strict control and hard, strong chill are desirable. Because irons containing oxygen have this peculiarity, they not only begin to show a chill at a higher silicon percentage than do coke irons, but they are also much more sensitive to chilling influences. High oxygen iron of 1.25 per cent silicon will show no more white chill than a coke iron if cast in sand, though, of course, it will be much finer grained. But, if cast against a chilling surface, it will show from ⅛ to ¼ in. white chill, whereas when coke iron reaches the range of silicon within which it will "take a chill" it is with difficulty prevented from chilling, even when cast in sand. With this great strength, with this power of making intricate castings without shrinkage cavities, and with its chilling power under accurate control, it seems that the metal should find its largest field, measured in tons, in car wheels, and tests of it for this purpose are now under way. Outside of that field, the metal is particularly adapted for steam, gas, or ammonia cylinders. As a substitute for or improvement on "gun iron" for strong castings, such as are now made from the air furnace, I believe that this metal cast from the cupola will find a large field of usefulness.

It is our hope, also, that with this metal it will be possible to produce malleable castings by melting in the cupola as easily as to produce them from the air furnace, as is done in present practice, because we can supply the carbon of any amount desired, and we can also introduce the oxygen, which it is largely the function of the air furnace to put into the iron now. This statement may seem radical, but I have had made an analysis of malleable iron, and found it to contain 0.13 per cent oxygen. Moreover, malleable iron, which under the microscope is shown to be composed of iron interspersed with little round nodules of graphite or temper carbon, is only a step beyond the metal which I have shown you, and, in my judgment, the new metal will eventually be found to constitute an intermediate step between malleable iron and ordinary cast iron. In malleable iron the carbon is all retained in the combined condition, as in cast, and is subsequently graphitized against the resistance of the solid iron by prolonged annealing. The new metal delays graphitization until the structure is sufficiently solidified to resist the formation of the graphite, the resistance being sufficient to force the latter into the forms entirely similar to those in true malleable.

Where castings are made from the maximum percentage of cheap scrap with the minimum of new iron to carry this, a softener is needed, probably in part because of the high sulphur of the mixed scrap; and as this new product tends to produce high combined carbon, and is a strengthener (and to that extent a hardener), it is not recommended for such castings. On the other hand, where a high silicon strong iron is needed, so that it may have good machinability and lend itself to rapid manufacture and yet be strong and fine grained when finished, the ideal material to give these qualities can be made by the new process, and, once the exact combination of strength and machinability desired by the foundrymen is known, that combination can be repeated under conditions of strict control to a extent not possible with any other product.

Iron from the blast furnace has to be taken as produced, not only in oxygen but in the other elements, but, by the use of a mixture of known components, in combination with this process of treatment, we are able to produce iron not only of a given analysis, but with certain physical qualities accompanying that analysis, a degree of control impossible to obtain in iron direct from the blast furnace.

(To be concluded)

Design of Acid-Resisting Iron Apparatus*

By Norman Swindin

The introduction into the chemical industry some few years ago of iron alloys capable of resisting the action of ordinary commercial acids was an event of great importance. To substitute for ordinary earthenware apparatus, whose uncertain behavior to the chemical engineer is only too well known, properly designed plant made of metal was held to be too good a thing ever to be realized. It was seen at once that the development of these alloys would confer upon the chemical engineer the same advantages in the choice of plant for dealing with acids as are possessed by his kinsman, the gas engineer, in dealing with his tars, liquors, and gases.

The marketing of plant and apparatus constructed of such alloys was welcomed with eagerness, and the pioneers of their manufacture were deluged with orders many times the capacity of their foundry. Inquiries for every conceivable vessel and appliance associated with the manufacture and treatment of acids came pouring into the office. From railway tank wagons to trembling contacts the firm was asked to quote for.

Since then the chemical industry in its demands has become more reasonable, for many of the early failures in the use of the metal were due to errors in design, and especially to the duplication in the new metal of plant designed to suit the properties and characteristics of glass and earthenware. No doubt certain extravagant claims put forth by the pioneers concerning the properties of their new alloy led the industry to expect little short of miracles, but the appearance in the market at the present moment of several forms of these alloys shows evidence of a sounder appreciation and understanding of their properties.

Most of these metals are alloys of iron and silicon in varying proportions, together with small quantities of other elements. Their acid-resisting properties are acquired at the expense of other desired properties which, to mention two of the most important, are toughness and softness. In other words, the more resistant the alloy is the more brittle and hard it becomes. In time, with development, these defects will disappear, but for the present the chemical engineer has to substitute for his present earthenware plant iron apparatus which will perform the same functions.

Though it is claimed that the resistance to corrosion offered by certain of the new alloys is general and not specific, it is found in practice that of all the ordinary commercial acids, nitric has the least action on them. Accordingly, therefore, the nitric acid industry is the one most concerned with the development of the alloys as they are at present manufactured.

In the first place, consider these alloys to be brittle and hard—in short, as a kind of earthenware metal. In reality they are, when properly made, by no means so brittle, but an exaggerated idea of this property will do no harm.

Though it is possible to obtain parts with flanges and faces nicely ground, or even machined, do not adopt them unnecessarily. Plain spigot and socket joints are to be preferred. Parts of plant intended for the transmission of heat may be made much smaller than the corresponding parts in earthenware. These alloys transmit about ten times the quantity of heat that can pass through an equal plate of earthenware or silica ware. Remember, it is not wise to order parts of plant weighing more than a few hundredweights, nor above 3 ft. or 4 ft. in diameter or in depth. Firms may, and

can, undertake the delivery of much larger pieces of plant, but their use is risky, and when they fail a larger quantity of material undergoing treatment is wasted.

The design generally of plant made of iron acid-resisting alloys follows that of steel practice, with the difference that these alloys are much weaker to resist fracture from the action of internal stresses. The crystals of these alloys are much larger than those of steel, and consequently do not knit together so well on cooling. The reduction of internal stress is the chief end which the designer keeps in view. Unequal cooling due to bad distribution of the masses of metal in the castings is the chief source of trouble in this respect. Consequently the thickness of the metal in the casting should be as uniform as possible.

The big masses of metal formed at the juncture of two or more walls must be avoided. Very often at these points segregation of carbon bodies takes place and cavities form in metal of peculiar sponginess.

As it is not possible to use chaplets (*i.e.*, small metal supports which the founder puts in the mould for holding up long cores), because they do not fuse properly in the castings; all cores must be as stiff as possible and well supported in the prints. This point affects design by demanding large openings to act as core prints, and to enable the core material and core irons to be easily withdrawn.

Sharp corners must be avoided, because it is well known that crystallization takes place in lines normal to the surface of the casting; hence at the corners lines of cleavage are formed which become sources of weakness.

It may be helpful to consider the design of the commonest elements of plant and apparatus in detail which the chemical engineer requires in iron alloys.

PIPES

Pipes are, in general, the most successful form in which these alloys can be cast. Pipes, as distinct from tower elements, should not exceed 2 ft. in diameter or be less than 1 in. in diameter. The length depends upon the diameter, but the shorter the better, as, on account of the difficulty of supporting a long core without chaplets, it gives the foundry a better chance of producing a sound casting. The following table may be of assistance in determining the length of pipes:

Diameter (inches).....	1	2	3	4	5	6	9	12	18	24
Length (feet).....	2	3 1/2	4	5	6	9	8	6	6	6
Thickness of Metal (inches).....	7/16	1/2	5/8	3/4	7/8	1	1 1/4	1 1/2	1 3/4	2

Whenever possible prefer sockets to flanges. There are now to be had excellent cements for every kind of acid liquids and gases, and as these bodies are seldom subjected to high pressures, an ordinary cemented joint can be made quite tight.

Pipes conveying liquids and gases under pressure must perforce be flanged, but the chief objection to them is that should the joint leak the corrosive body attacks the wrought-iron bolts. Flanges should be provided with a deep facing strip and be truly machined or ground.

At first the bolts were fitted in cast in slots of ample clearance, but cast holes, round or square, should be specified because the nuts, washers, and bolt heads have an increasing bearing surface, thus reducing the intensity of pressure on screwing up. Fracture of the corners of the slots is a frequent source of trouble.

The ordinary British standard pipe flanges for heavy steam pipes may be safely adopted as regards diameter, number, and position of bolts, and diameter of bolt circle. The thickness of flange should be about one and a half times the thickness of pipe walls.

There is doubtful wisdom in the use of webs. They

*From the "Chemical Trade Journal and Chemical Engineer" (London), Oct. 14, 1916.

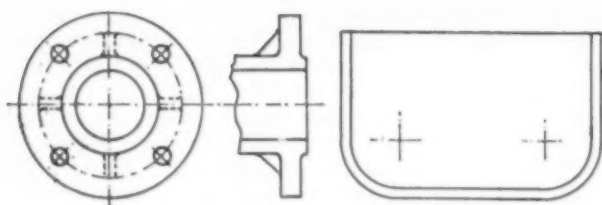


FIG. 1—PIPE FLANGE

FIG. 2—PAN CONSTRUCTION

facilitate the flow of metal into awkward corners of the casting, but as they are usually made large and fill the angle across which they sit, webs often crack, and thus serve no purpose. When adopted, webs should be small, not filling the angle, and slightly thinner than the walls of the casting.

Fig. 1 shows a typical form of pipe flange.

PANS, VESSELS, AND STILLS

The most successful form of casting for acid-resisting iron alloys, or indeed for any metal, is a hollow sphere. The nearer the castings approach this form the more reliable they are in use. As the lines of crystallization are in all parts normal to the surface and parallel to each other, the internal stresses are in consequence reduced to a minimum.

The design of pans and vessels, therefore, should evolve from the sphere. Flat surfaces should be avoided wherever possible; if they cannot be, then on no account must a flat surface exceed 18 in. square.

The intersection of two flat surfaces must be carried out by large radii, as in Fig. 2; in other words, there must be no sharp corners.

Circular pans with elliptical or hemispherical bottoms are excellent shapes. The only objection to them is that they do not sit well unless provided with feet or lugs, which, being projections, are liable to fracture if knocked or jarred unduly.

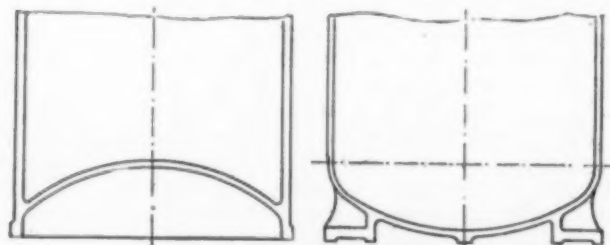
Two spherical ended pans, when bolted together flange to flange, form a very convenient acid tank or receiver. These have been made 5 ft. by 10 ft. long, but it is not recommended to specify them so made, to be more than 3 ft. 6 in. diameter by 10 ft. long—that is to say, made up of two pans, 3 ft. 6 in. diameter by 5 ft. deep.

For such vessels as receivers, bleachers, Woulfe's bottles, which are usually required with flat bottoms, the difficulty of casting these flat bottoms is overcome by dishing upwards as shown in Fig. 3. The form shown in Fig. 4 is, however, to be preferred.

The outlet or run-off pipe of stills should be as large as possible, and conical in section. In other words, the pipe should be attached to the still by large radii, as in Fig. 5.

Still covers and lids do not present great difficulties provided they are well dished. The best section for these is a semi-ellipse with flanges.

The very shallow pans used for concentration purposes are ribbed and corrugated to break up the flat surfaces. These ribs and corrugations, in addition to overcoming foundry troubles, provide an increased heat



FIGS. 3 AND 4—BOTTOM CONSTRUCTION

transmission surface. Pans of this pattern have been cast 3 ft. long by 18 in. wide and 6 in. deep. The design of lip needs care. The lip should be well curved and carried below the overflow level.

NITRIC-ACID PLANT

As before stated, it is in the nitric-acid industry that the greatest development of the use of these alloys is taking place. Their introduction into the atmospheric nitrogen industry has rendered possible the production of strong nitric acid by concentration from 22½ per cent acid.

Studying the ordinary nitric-acid plant, where sodium nitrate is treated with strong sulphuric acid, the greatest defect is the condenser. This may consist of a yard full of earthenware Woulfe's bottles connected in series, coils of Doulton or other ware, and of silica, vertical standpipes connected with glass tubes (Hart condenser), special forms of thin earthenware pipes (Gutt-mann). The size of these condensers is enormous compared with the small quantity of heat that has to be

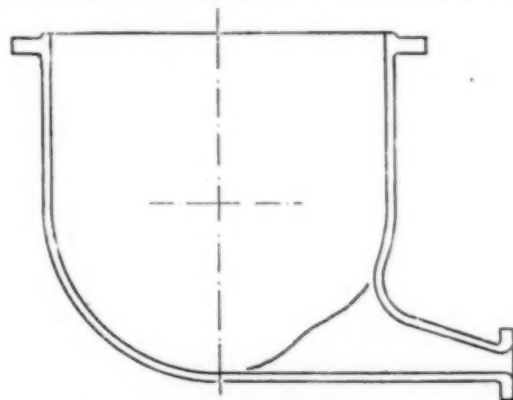


FIG. 5—STILL AND PIPE

absorbed to condense the nitric-acid vapors, because the heat conductivity of the material is so bad.

Iron alloy condensers in the first place are much smaller, and as the condensation can be performed rapidly, the reaction in the still can be forced so that a charge that usually take thirty-six hours may be reduced to sixteen hours.

The usual form of metal condenser consists of a series of pipes fixed in frame for air cooling, or better placed in a water tank with the joints outside. The joints are usually flanged, but it is much to be preferred to have sockets, which should be fixed in a vertical plane.

The now familiar form of "S" pipe suggests itself as the best means of having vertical socket joints with horizontal pipe (see Fig. 6). If these pipes are gilled as in Fig. 7, and fitted so that they can be covered with films of water, no better form of condenser need be desired.

The newly developed industry of atmospheric nitric acid has brought forth many difficult problems. To remove the water from 22½ per cent nitric and produce 100 per cent acid, it has been found necessary to evaporate, fractionate, and distill in succession. Plants have already been designed to carry out the first two operations in vacuo and constructed entirely of acid-resisting iron alloy.

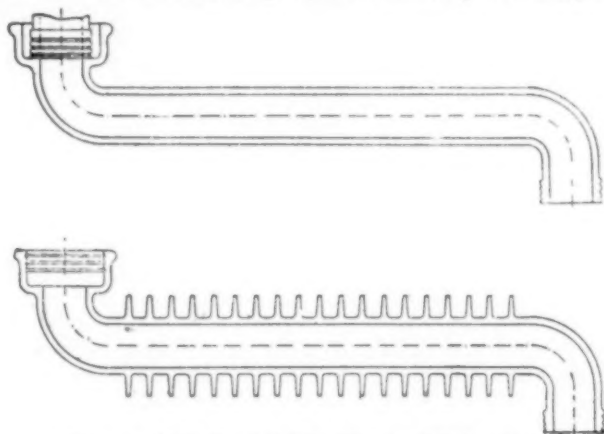
Apart from the difficulty of grinding or machining a great number of joints with the necessary accuracy—for it must be understood that this plant is a great departure from the simple still set in brickwork with condenser pipes that need not be machined at all—the designing of a steam-heated still presented a stiff problem.

The heating elements of the still were, after many disappointments, made by casting in a strong steel coil in the walls of the element. These elements were like inverted saucers, and a number of them resting together were bolted between a pan-like base and a still cover. It is not intended here to describe in detail how this was done; it is sufficient in an article of this nature to mention the fact that steam-heated stills so constructed can be obtained.

The condenser of this plant deserves mention. It was constructed on the lines of an evaporative condenser of a condensing engine, and was placed outside the building and supplied with water in the usual way. The function of the condenser was different from that attached to a nitric-acid plant. It had to condense $2\frac{1}{2}$ tons of water-vapor for each ton of acid produced.

SULPHURIC-ACID CONCENTRATION

The early forms of apparatus for carrying out this terrible business were not altogether successful. Though thousands of cascade pans and basins have been supplied and put to use, the silica basin, notwithstanding its low heat conductivity and its liability to flake, is



FIGS. 6 AND 7—CONDENSER CONSTRUCTION

still largely used. Where iron-free acid is required, silica is imperative, for none of the iron alloys can resist absolutely the action of weak sulphuric acid.

It was early found that when cascade plants were wholly fitted with iron alloy pans the iron sulphate formed in the top basins where the acid was weak was deposited in an anhydrous condition in the lower pans, and eventually stopped the flow of acid, or, rather, directed it down into the furnace, where it made the usual mess. It is usual at the present time to fit cascade basins of iron alloy only in the lower part of the run, for strong acid does not attack them, and they, of course, transmit the heat much easier.

For denitrating mixed acid, towers made of iron alloys are very successful. They are made up of socket pipe lengths and placed on a bottom element having an outlet for acid and an inlet for steam. An ordinary form of still elbow with seal on the top completes the tower.

Bitumens.—Arranged in convenient question and answer form with space for additional memoranda, The Barber Asphalt Paving Company has published an "Outline for the Study of Bitumens." While the whole subject of bitumens is covered, the outline has been prepared with especial reference to the asphaltic materials used in highway construction. In addition to the answers provided in the outline itself, there are references to most of the standard text books on highway engineering. While prepared especially for school use, the outline is a convenient means of reference for anyone interested in bitumens.

Inadequacy and Inconsistency of Some Common Chemical Terms

By Carl Hering

The fact that our grandfathers did things in a certain way, and that this way was good enough for them, is not always a safe reason for our doing so to-day, although when stated in different terms this reason is often accepted to-day by some as safe and sufficient. Physical chemistry has done so much lately for the advancement of chemistry that its dictates should receive respectful consideration.

The purpose of the present article is to point out the looseness, inconsistency and inadequacy of some common conceptions, terms, and expressions, in chemistry, and to suggest reforms.

Valence. The term valence, meaning the number of bonds which unite the elements, or the number of atoms of different elements which combine into a molecule, has been used rather loosely, causing confusion and inconsistencies. It would avoid confusion and be more clear and precise, if the term "valency" were used to express the general *property* of an atom of that element to combine with other atoms in various proportions, while the term "valence" should then be limited to the *one particular value* in any one specific case. Thus it should be said that copper as an element possesses the property of having a *valency* of 1 and 2, and that in cuprous chloride it has a *valence* of 1 and in cupric chloride a *valence* of 2. This reform has already been suggested by others and should be encouraged.

Different kinds of bonds. In what are known as structural formulas, some of the bonds are sometimes supposed to combine atoms of the *same* element. Thus in H_2O , one of the two bonds of O is supposed to unite the two atoms of O with each other. The modern and probably generally accepted theory of chemical reactions, at least in cases of electrolysis, shows that every one of the bonds between different elements (for a mono-valent gram atom) which is destroyed or created by the current involves an electric charge of one faraday (96,500 coulombs or 26.80 ampere-hours); this is true for all the elements, at least in electrolysis; the ions carry these charges from one electrode to the other; this is the basis of the generally accepted Faraday's law. To separate from each other two or more atoms of the *same* element by electrolysis, which would imply setting free the same element at both electrodes, is apparently not possible, and if this is true it must follow that those bonds which are supposed to unite atoms of the same element, if they exist, must be physically of a different nature, and should therefore be distinguished in some way or by some term from the other kind which are well known to exist and are universally recognized. In what follows the only kind of bonds referred to are those which unite different elements, and the term valence is here used as referring only to those.

Negative valences. Most of the elements will, in electrolysis, always go to one particular electrode and never to the other; hydrogen, for instance, always goes to the cathode and oxygen always to the anode. According to the modern accepted theories, hydrogen atoms always carry positive charges of electricity and the oxygen atoms always carry negative charges. This alone should be a sufficient reason to give the valences distinguishing signs, and therefore to say that the valence of hydrogen is + 1 and that of oxygen — 2, hence to use negative valences, as was suggested many years ago (see the writer's article in this journal, January, 1903, p. 169).

But there is another and even more important reason for doing so. Some of the elements, namely, antimony,

arsenic, bromine, carbon, chlorine, iodine, nitrogen, phosphorus, selenium, silicon, sulfur and tellurium, seem to act sometimes like hydrogen in this respect, and at other times like oxygen; or according to modern theories they sometimes carry negative and sometimes positive charges, hence it is inconsistent not to distinguish between these different states as is easily done by giving the particular valence a sign; that is, by stating whether in any particular combination the valence is positive or negative.

As an illustration of the utility of this conception of negative valences, the S in H_2S must be considered to have a valence of -2 , while in SO_2 it must be considered as having a valence of $+6$. Hence to change the former into the latter involves a change of valence of -8 (the algebraic difference) and electrochemically this means 8 faradays and not 4, which would be the numerical difference if the negative sign be omitted; the sign of the difference 8 designates the direction of the current which would produce this result. Another illustration is the "oxidation" of methane CH_4 (more consistently written H_4C) into carbon tetrachloride CCl_4 . In the former the carbon should be stated as having a valence of -4 and in the latter $+4$, hence the change of valence involved is -8 and not zero, as would follow if the signs are omitted.

Change of valence. All electrolytic reactions must be considered broadly as involving a change of valence, no other kind seems to be known, and the quantitative calculations are based on this change. The oxidation of ferrous into ferric sulfate, for instance, involves a change of valence of 1 in the iron. The setting free of oxygen from water is depriving it of all of its 2 bonds, hence is a change of valence of 2. Some quantitative electrochemical calculations are greatly simplified by basing them on this change of valence, as every unit valence of such change requires 26.80 ampere-hours for each mono-valent gram atom of the elements.

Zero valence. By a zero valence chemists usually mean that the element never combines with others, which is the case for instance with the noble gases like argon, etc. This is not consistent because any element in its free and uncombined state necessarily has no bonds connecting it with other elements, hence when in that state it must be considered as having a zero valence. Reducing the metals or the gaseous elements to their free state by electrolysis, means changing their valence from what they had in the combination, to zero. And in those elements which have both $+$ and $-$ valences, the change from one to the other necessarily involves passing through zero, which is their free state. A consistent way of stating these facts would be to say that the *valency* (a property) of the noble gases is zero, and that the *valence* (a specific value) of all the elements, is zero in their free state. Or it may be said that elements like argon are non-valent.

Reduction. All chemical reductions, when interpreted according to modern accepted theories, mean a reduction of the valence, whether from $+$ to or toward 0 or from 0 to $-$ or from $+$ to $-$. Broadly therefore it is physically the same process to set free hydrogen from water, a reduction from $+1$ to 0, as it is to combine free oxygen with some element as far as the oxygen is concerned; that element is properly said to be oxidized, but the oxygen must be said to be reduced, as its valence (and therefore its oxidizing property) has thereby been reduced from 0 to -2 . Chemists will not like to apply the term reduction to this change in the oxygen, yet as it is physically exactly the same process and in the same direction as setting free combined hydrogen or a metal, it necessarily must be placed in the same class, and if it is not palatable to the chemist

to embrace this under "reduction," then a new term should be coined for covering this physical process more broadly.

Oxidation. Similarly with the chemical term oxidation, though in this case the term is even worse as it implies a combination with oxygen, yet it is to-day by general consent (though inconsistently) extended to include combinations with other elements also; $Cu + Cl = CuCl$ is called oxidation.

Setting aside the views of our grandfathers, what this word is really intended to mean in its broad sense is the physical opposite or reverse of reduction, hence the same process in kind but different only in direction; according to modern theories therefore it means broadly an increase in valence, from $-$ to or toward 0, or 0 to $+$, or $-$ to $+$, and of course this is independent of whether oxygen itself is involved or not. To combine a free element with oxygen, fluorine, etc., is to increase its valence from 0 to $+$, which process is to-day called oxidation of the element (not of the oxygen). But it is physically exactly the same process as to increase the valence from $-$ to 0, as for instance in setting free sulfur from H_2S , in which case the change of valence of S has been from -2 to 0. It is necessarily also exactly the same physical process as in setting free oxygen from an oxide, as the valence of the oxygen has thereby been increased from -2 to 0; to call this "oxidizing the oxygen" would probably not be palatable to the chemists, yet that is what it really is when considered broadly as a physical process; this inconsistency however is lessened by the fact that such oxidized oxygen (free oxygen) is a stronger oxidizing agent than combined oxygen, just as reduced hydrogen (that is, free) is a stronger reducing agent than combined hydrogen.

A term is therefore needed for expressing this physical process, namely the exact reversal of chemical reduction (a reduction in valence), and meaning broadly an increase of valence from $-$ to or toward $+$. Many years ago Prof. J. W. Richards suggested the term "perduction" (which the present writer used in this journal, January, 1903, pp. 172 and 174); the objection to it is that the chemists already use the prefix *per-* in the sense of *super-*, hence it gives rise to confusion. Numerous other terms have been suggested, like *preduction*, *induction*, etc., but the best one seems to be "adduction," suggested recently by Dr. Frederick H. Getman, as the prefix implies an addition, hence the sense of increasing or adding to the valence.

In the opinion of the writer the words "adduction" (for oxidation) and "reduction" are satisfactory terms to use, for these two identical though opposite or reversed physical processes, as it merely involves overcoming unreasonable prejudices against extending the old and well known term reduction to embrace broadly all cases of reduction of valences, and as this would not involve the inconsistency that was involved in applying the word "oxidation" to other elements than oxygen, there ought to be no difficulties in doing so.

Philadelphia, Pa.

Chain Drive for Aniline Kettles.—The Link-Belt Company with offices in the principal cities has issued a pamphlet illustrating the use of chain drive for operating reducers and other dye making apparatus. Chain drive is being used by the Schoellkopf Aniline & Chemical Works, Buffalo.

Removal of Iron from Water.—"The Removal of Iron from Municipal Water Supplies" is the title of a bulletin of the Division of State Chemical Research of Kansas. The author is James W. Schwab, and the bulletin appears as Vol. XVII, No. 8, of The Bulletin of the University of Kansas.

Synopsis of Recent Chemical and Metallurgical Literature

Brass

Annealing of Arsenical Brass.—In a paper presented at the recent meeting of the British Institute of Metals in London, Messrs. C. H. MATHEWSON and E. M. THALHEIMER of the Sheffield Scientific School, Yale University, gave the results of a study of arsenical brass for use in making heavy tubes. The tests were made on brass mixtures based on the use of Copper-Range Lake copper with 0.3 per cent arsenic, with the object in view of finding a mixture which would withstand hot-rolling into a circular disk $\frac{1}{2}$ in. thick, which is then annealed and cupped preparatory to being drawn into tubing. The alloy therefore, must also be very ductile when cold.

The results of the tests show comparisons between the properties of brass containing (1) 62.5 per cent copper and very little (0.024 per cent) arsenic, (2) 62.5 per cent copper and 0.120 per cent arsenic and (3) 61 per cent copper and 0.139 arsenic.

In the mechanical tests made after annealing and quenching at temperatures between 450 deg. C. and 750 deg. C., the arsenical brass was found to be superior in elongation and strength. The alloy with the smaller percentage of copper appeared less sensitive to variations in the rate of cooling. In general the authors concluded that the alloy made from the arsenical copper was superior for tubing to that made with electrolytic copper. To obtain the best results the rate of cooling should not exceed 5 deg. C., fall of temperature per minute to 550 deg. C., when the material may be quenched.

Reclamation of Brass Ashes.—A paper dealing with the recovery of the valuable metal and unburned fuel from brass ashes was presented at the Cleveland meeting of the American Institute of Metals by ARTHUR F. TAGGART. A sizing test on a typical casting shop ash showed 10.05 per cent copper, which for a 65-35 brass means about 4.5 per cent zinc. A sorting test on this material showed about 15 per cent unburned and partially burned coal. This is for normal operation, whereas at present these figures are much higher. The gross value of the normal ash is \$32.78 per ton, and under forced production \$100.90 per ton.

The method of recovering these values varies in different plants, according to the size of the plant and the consequent production of ashes, and according also to the technical talent available. A small number of small plants sell directly to local junk dealers, others ship to custom scrap metal plants; the large majority treat the ashes by some crude method to recover the coarse metal, some of these selling the fine residue at absurdly low prices, the others using it for filling in low ground around the plant. Finally there are a few of the larger companies that treat the ashes in modern, well-designed reclaiming plants, obtaining as products clean coarse metal which can be melted directly into ingots, and fine rich concentrate which is smelted on the ground and which also yields ingot metal.

The factors which must be considered in the design of such a modern plant are:

1. The character of the ashes.
2. The quantity of ashes.
3. The treatment of the products of the concentrating plant.
4. The characteristics of the machinery to be employed.
5. Costs, both capital and operating, and their effect on percentages of recovery.

The general system of handling these factors, once they are determined, is by the method of "cut-and-try."

The first step is to make a sizing-sorting-assay test of the original ashes. From this is gained necessary information concerning the distribution of metallic values and coal and the amount of slag that must be ground. Grinding, sorting and microscopic tests on the slag afford knowledge as to the distribution and size of the metallic shot which it contains and thus tell to what extent comminution must be carried in order to free for concentration the economic maximum of metal. From the knowledge thus gained an experimental flow-sheet or mill scheme is built up in the laboratory and a test run made to confirm the deductions from the original test. With the further knowledge gained from this test run, and, if necessary, subsequent test runs, a tentative flow-sheet for the mill installation is drawn up.

The costs of the plant will depend on the character of the housing. A small plant, with a capacity of 20 tons per day, housed in a wooden building, will cost \$15,000 to \$20,000, a larger plant, with a capacity up to 200 tons per day, housed in a steel building, will cost \$80,000 to \$100,000. A considerable reduction in these figures can be expected if a concentrating plant alone is built. If the plants of the writer's acquaintance are typical, either will pay for itself in increased saving and decreased cost of operation within a couple of years.

Seasoning Cracking and Self-Annealing of Brass.

—An interesting contribution on this subject was presented at the recent meeting of the American Institute of Metals in Cleveland by W. ARTHUR of the Frankford Arsenal, Philadelphia, Pa. The author states that it is only in recent years that much serious thought has been given to one of the less prominent but most important peculiarities of brass, viz., self-annealing and seasoning cracking.

Since it requires several years for any self-annealing or seasoning cracking to manifest itself to any marked degree, it is to be expected that any extended study would be much delayed. Often the brass which might show this property is entirely used up, worn out or discarded long before any marked change in the metal has occurred. However, there are instances where it may be necessary to store the brass or its use may extend over a period of a number of years. In such cases seasoning cracking or self-annealing is quite important. Thus it has been possible to make the necessary investigations only in cases where the metal could be kept under observation for a long period of time.

It is a familiar fact that hard-drawn brass wire when held in storage for any considerable length of time shows a decided tendency to lose its hardness or spring temper, and in a few cases where the temperature has been abnormally high these changes have come about in a comparatively short time. In many instances where brass wire has been employed because of its hardness or spring temper it became quite useless, though it had not been in actual service but held in storage. In some lines of work where brass springs are used the present tendency is to discard the brass and use steel springs which do not exhibit changes due to age.

Metallographic methods have not been in use long enough to enable us to ascertain the exact nature of this intercrystalline change, and so far as we know no direct proof is available that recrystallization actually takes place, but all evidence points in that direction. The question naturally arises why does not hard-drawn brass show cracks when annealed in the ordinary way? So far as we are able to observe, season cracks begin on the surface and extend inward. Any cracking due to a change in volume would be counteracted by the expansion due to heating.

The significance of this problem of season cracking and self-annealing is such that it should receive much serious attention from our best metallurgists. We cannot pass it by without considering it, and it is to be hoped that the near future will be productive of much data which will enable users of brass who have difficulties with this problem to more intelligently cope with it.

Valves

Failure of Manganese Valve Castings.—An investigation was made at the Bureau of Standards of the failure of a number of manganese valve castings in the Catskill Aqueduct. The results were described in a paper by PAUL D. MERICA and C. P. KARR presented at the annual meeting of the American Institute of Metals in Cleveland. A somewhat fuller account will later be published as a Technologic paper of the Bureau of Standards.

The castings were quite large weighing up to 22,000 lb., and were such that neither preheating of the casting for the welding or burning in of defective areas, nor subsequent annealing of the whole casting could be conveniently carried out.

As a result of the local heating of welding and consequent unequal contraction of different constrained parts of the casting, stresses remained in the casting, particularly severe near and within the burned-in areas; these stresses were in all probability responsible for the subsequent failure at these points.

The determination of the values of such stresses, in the case of castings of manganese bronze, in correlation with the physical properties and structure of this material as welded or burned-in seemed desirable.

The experiments described have indicated how readily severe stresses may be introduced into a casting by the burning-in or welding of a "constrained" area or portion of it. The form of casting used in these experiments was such that no bending or distortion, tending to relieve the stresses, was possible during cooling, and this must be borne in mind in applying these results to the consideration of the effect of burning-in of more complicated shapes, where such above-mentioned distortion does occur.

In the spherical shell or dome-shaped valve castings of the New York Board of Water Supply, for instance, burning-in would tend to flatten the shell, and in so doing, partially relieve these stresses, and it is most difficult to calculate the stresses in such a case. The authors are inclined to believe that even in these cases local stresses of values equal to the true elastic limit must have been produced, and which would account for subsequent failure.

The conclusions drawn, are:

(1) That the welding-in of constrained portions of castings (forgings, wrought articles, etc., naturally, as well) of manganese bronze, produces in general local initial tensional stresses within and near the burned-in zone, of value equal to the true elastic limit of the material, unless the shape of the casting is such that extensive distortion may occur.

(2) That such castings should, therefore, be either preheated carefully for welding, such that all parts of the casting cool down together from a dull red heat, or the casting should be subsequently annealed. Experience indicates that a low temperature anneal is sufficient for this purpose, *e.g.*, from 400 deg. to 500 deg. C. (760 deg. to 945 deg. Fahr.) for from one to two hours. Either of these precautions should eliminate these local stresses resulting otherwise from the burning-in and should produce castings free from danger of subsequent cracking.

Molybdenum

Metallurgical Treatment of Molybdenum Ores.—In the Colorado School of Mines *Quarterly* for July, 1916. Prof. HERMAN FLECK in an article on molybdenum gives considerable data on the concentration and reduction of molybdenum ores. He reviews the various methods of concentration which have been tried.

"Nearly everything has been tried of ore-dressing nature on the molybdenum ores—no two of which are alike—and, on the whole, with surprisingly interesting results. Molybdenite is different from most minerals. It is heavy like a metallic sulphide and behaves in part like these, and then it is flexible, and not brittle, with strong basal cleavage and a tendency to flake like graphite or mica. Ordinary methods of concentration are hardly applicable.

"However, combinations of heat, newer principles, such as flotation, magnetic and electrostatic separation, have done much to win good concentrates from ores which were looked upon quite unfavorably a few years ago. Only rarely does the mineral occur so coarsely divided that it may be hand-picked."

Processes used in Australia, Norway, United States and Canada are reviewed. On the reduction of concentrates Professor Fleck writes as follows:

"Molybdenum is brought on the market in two forms, powder and ferroalloy.

"The first of these is invariably made by heating some form of oxide with a reducing agent. Carbon in form of charcoal is usually employed. The first stage of reduction is the dioxide which forms readily, and unlike the trioxide is not readily volatile. Prolonged heat and high temperature effect further reduction of this to metal.

"The second form, ferromolybdenum, with varying molybdenum contents, is made by the use of the electric resistance furnace, either direct from the sulphide or from the roasted high-grade sulphide. The advantage here is that impurities may be slagged off whereas in case of powdered metal, unless the impurities are subject to extraction with a solvent, they remain with the metal.

"Before the increased present demand manufacturers were exacting. Standard requirements for concentrates were 85 to 90 per cent MoS₂ and except in very small amounts, copper, bismuth, arsenic and tungsten, when present, were penalized. Because of increased demand the requirements are made more easy to meet.

"The reasons are obvious. The purer the molybdenite the less treatment required for the final operation of reduction. When the demand is greater than production, as at present, the increase in price takes good care of additional preliminary refining treatment of lower grade material. The preparation of the oxide in commercially pure form is not an easy matter.

"This may be done by roasting the sulphide first to oxide and then leaching the mass with ammonium hydroxide, which dissolves the oxide to form ammonium molybdate. Copper oxide forms an objectionable constituent because it also dissolves and reappears in the subsequent evaporation of the ammoniacal solution. Evaporated to crystallization, preferably under reduced pressure, so-called ammonium molybdate crystallizes out from the filtered solution. This contains 81.55 per cent of molybdic oxide, 8.27 per cent ammonia and 10.19 per cent water. On ignition ammonia is driven off and molybdic oxide results. A previously mentioned process whereby the oxide is won by volatilization directly from the ore, may be referred to here.

"When the oxide is heated in a wind furnace with carbon in graphite crucibles a dark powder results which is commercial molybdenum. An analysis of such a

product showed 95 per cent molybdenum and 2 to 3 per cent carbon combined by cementation. The metal forms carbide readily. With care a product may be made 99 per cent pure.

"Among the early manufacturers Sternberg and Deutch in 1892 made a metal which contained 3 per cent carbon by igniting precipitated calcium molybdate, in similar fashion, with carbon. Their factory was situated near Berlin and the capacity was 200 kg metal a day. The admixed calcium oxide was leached out of the metal with hydrochloric acid. The metal at that time brought 86½ cents a pound. It contained 3 per cent carbon.

"Moissan first introduced the use of the electric furnace. By heating ammonium molybdate he made the dioxide which he treated with 10 per cent pure carbon. The resulting metal contained carbide.

"Guichard produced a metal of high carbon contents directly from the sulphide in the electric furnace. The ore, nearly pure molybdenite, gave a metal of 91.5 per cent molybdenum contents. Current used, 300 amp., 50 volts.

"Robert Keeney of the Colorado School of Mines found that either the raw or roasted ore can be used in making ferromolybdenum in the electric furnace. Lime is used as a fluxing and desulphurizing agent. Ferric oxide is subsequently added for decarbonizing purposes. In the case of direct use of molybdenite the sulphur slags off in form of calcium sulphide. With a current of 900 amp., 50 volts, sulphur is found to be entirely expelled from molybdenite. However, about 7 per cent of carbon is absorbed, partly graphite. This can be reduced by the decarbonizing action of freshly added oxide. Wulfenite when fluxed with sodium carbonate gives oxide of lead and sodium molybdate. The latter is soluble in water; the former is not. From the solution the oxide can be gotten and worked into metal. Such mention seems necessary now since Wulfenite in 1914 found a good market at 60 cents per pound of MoO₃ contained in good grade concentrate.

"The thermit or aluminothermic process, which depends upon the greater heat of formation of aluminum oxide for reduction, produces a high-grade metal free from carbon. Ninety-eight to 99 per cent of molybdenum and the remainder iron is the composition of the product.

Porcelain

Constitution of Porcelain.—The results of a study of porcelains made at the Bureau of Standards is given in the *Journal* of the Washington Academy of Sciences by A. A. KLEIN. A more detailed account will appear later as a Technologic Paper of the Bureau of Standards. Bodies and mixtures of kaolin, feldspar-kaolin, feldspar-quartz, and feldspar-clay-quartz were burned at various known temperatures and examined microscopically. Kaolin appeared homogenous when heated up to 1200 deg. As the temperature is increased from this point dissociation begins, at first slowly, then at an increasing rate, until at 1400 deg. dissociation is complete. The products of dissociation were found to be silica and aluminium silicate, the latter being identified as an amorphous phase of sillimanite.

"Up to 1340 deg. in mixtures of quartz and feldspar the quartz dissolves to only a small extent in the feldspar glass. At 1460 deg. the quartz is practically completely dissolved in specimens having as high a quartz content as 50 per cent quartz to 50 per cent feldspar.

"In specimens containing kaolin and feldspar the kaolin dissociates entirely at 1340 deg. The amount of crystallized and amorphous sillimanite increases with an increased content of kaolin, at least to a concentration of 50 per cent kaolin to 50 per cent feldspar.

"At 1460 deg. apparently 10 per cent kaolin is entirely soluble in the feldspar glass. With higher concentrations of kaolin the amount of crystallized sillimanite increases. The needle crystals are well developed and comparatively large.

"At 1310 deg., in quartz-clay-feldspar bodies, the feldspar is present as a glass; the clay shows almost complete dissociation with the formation of amorphous sillimanite mainly and but little crystallized sillimanite, while the quartz is undissolved and the grains may still be of considerable size, up to 0.2 mm., or more, depending upon the fineness of grinding.

"By burning these bodies at 1380 deg to 1400 deg. the feldspar glass dissolves considerable quartz, there being only a comparatively small amount of residual quartz remaining. The quartz grains are much rounded and etched and they seldom show a length over 0.06 mm. The clay is dissociated with the formation of crystallized sillimanite, although an extremely small amount of amorphous sillimanite may be present.

"The changes involved by burning commercial bodies are identical with those of laboratory prepared bodies. The quartz grains observed in whiteware and in low-fired vitreous ware are large and angular, showing a size of 0.2 mm., or more, whereas in the hard porcelains, due to solution, the quartz grains are rounded and etched, and seldom exceed 0.05 mm. in length.

"The constitution and the microstructure of porcelain depend upon the temperature of burning, and change as this temperature changes. This has served as a basis for the estimation of the probable burning temperatures of the commercial bodies, a fact which was accomplished with success, the error involved being within 25 deg. It appears that the time-of-burning factor is by no means as important as that of the burning temperature in determining the constitution and microstructure of the ware.

"No cristobalite or tridymite has been definitely observed in any of the laboratory or commercial bodies examined. It appears that the quartz dissolves in the feldspar glass more readily than it inverts to the other modifications of silica.

"In conclusion, it may be stated that the petrographic microscopic study of porcelain has led to interesting and, it is to be hoped, important technical results. It has placed the chemical and physical processes involved in the formation of porcelain on a more quantitative thermal basis. Furthermore it has offered a means of estimating the burning temperature of a ware by an examination of a fragment much too small in size to be satisfactory for even a chemical analysis."

Oxygen

Blasting with Liquid Oxygen in Salt Mines.—Some interesting data on this method of blasting which has been advanced by the war are given in *Engineering* (London) for Sept. 22, 1916. In experimenting with the process cartridges were charged with charcoal and the carbon impregnated with liquid oxygen. The ignited carbon then burned with explosive energy. Great difficulties were encountered as liquid air does not admit of being stored in closed vessels and evaporates rapidly in open vessels. In 1915 experiments with liquid oxygen cartridges were energetically taken up by the salt works at Winterhall, acting in conjunction with the famous potassium salt mines of Stassfurt and other localities, and considerable progress has been achieved, according to an illustrated article by Dr. Heberle of Berlin, published in the journal *Kali* of Jan. 15 and April 15, 1916. The cartridges are simply made of texture, paper, or cardboard and are charged with soot or charcoal, mixed sometimes with other ingredients, or with kieselguhr

and petroleum. The soot has answered well. A cap of fulminate of mercury is generally added for ignition; this cap should not be rigidly connected with the cartridge, to facilitate impregnation of the carbon. The Marsit cartridge does not need any cap. Ignition is by fuses or by electric wires. Dr. Hecker is said to have devised suitable ignition devices which do not require the instantaneous ignition of all the cartridges in a circuit. Impregnation of the precooled material may be effected either by pouring the oxygen into the cartridge through a tube of filter paper (Baldus and Kowatsch), or by immersing the cartridge in the liquid; the latter procedure is preferable. The oxygen should be of high concentration, 99 or 97 per cent. The immersion of a cartridge takes from 5 to 25 min. The experiments seem, at any rate, to have established several important facts. A cartridge can be so impregnated that it will still explode 10 or 15 min. after being tamped in its hole; means have even been found by which cartridges could be impregnated at the surface and be taken down and used as much as three hours later. This is not considered important for salt mines, because the general conditions there demand that many appliances should be kept below. But the fact that not more than two men are required to look after up to twenty blasts would be important. Glass vessels or bottles were first tried for the transport of the liquid oxygen; but some unpleasant experiences were met with, and the transport vessels and immersion vessels are better made of metal. A hole may require 2 liters of liquid oxygen. The immersion cylinders at Winterhall have a diameter of 25 cm. and 38 cm. height; but big cartridges, 32 mm. in diameter, are sometimes used, and as many as five cartridges are fixed in one hole of a depth of 150 cm. This great depth of the bore-holes is characteristic of salt blasting. Heberle estimates that one blast would cost 14s., counting materials and labor. That would not be cheap, and, he adds, moreover, that conditions may be less favorable elsewhere than they are at Winterhall. The actual dearth of explosives during war time may be a factor in these attempts. But there has been a good deal of experimenting on oxygen cartridges in England as well, of course, and the point is to adapt the extra plant to the special conditions and to utilize it fully. Sawdust, we see from another German publication on mines, has not answered well as an absorbent for oxygen in cartridges, and it was observed in a limestone quarry that the percentage of carbon monoxide present in the air went up to 0.15 after firing two of these shots. That would be a grave matter.

Recent Chemical and Metallurgical Patents

Copper, Lead and Zinc

Wet Copper Process.—A method for the extraction of metals from ores has been patented by HENRY B. SLATER of Riverside, Cal. The principle involved is to subject the ore containing the metal (copper) to the action of a solution containing alkali metal chloride, and a metallic chloride capable of reduction to a lower chloride, together with hypochlorous acid, then precipitating the copper from solution and subjecting the solution to the action of free chlorine in the presence of a metallic hydroxide to regenerate the solution containing hypochlorous acid together with a metallic chloride capable of reduction to a lower chloride for use in a cyclic process. To convert the metal value into chloride, sodium chloride is used. Hydrochlorous acid and ferric chloride are the reducing agents employed. A calculated amount of sodium hydroxide is then added to precipitate the iron in solution, and further additions of sodium hydroxide made will then precipitate the copper in the

hydroxide form. The solution containing the reducing agents is regenerated by adding free chlorine to the liquor in the presence of enough iron hydroxide to give ferric chloride. The copper hydroxide obtained is filtered, washed and pressed into slabs which have an iron mesh work in the center. These slabs are used as cathodes in an alkaline electrolyte, usually sodium hydroxide, after having been dried and heated to 600 deg. C. in a muffle furnace. The hydrogen liberated during electrolysis serves to reduce the copper oxide on the cathode, and, it is claimed, gives a very pure product. 1,195,616, Aug. 22, 1916.)

Leaching Process.—HENRY B. SLATER of Los Angeles, Cal., has patented a process of making a leaching solution for the extraction of metals from their ores. Briefly, it consists in subjecting a solution of ferrous chloride and sodium chloride to electrolysis in the anode compartment of an electrolytic cell, and simultaneously subjecting a solution of sodium chloride to electrolysis in the cathode compartment of the same cell. The two solutions are kept separated by a porous diaphragm. This diaphragm should be of such a permeability as to permit the cathode products to diffuse through it. The electrolysis should be maintained after all the ferrous chloride has been converted to the ferric condition, so as to permit the formation of hypochlorous acid by the reaction of the chlorine set free in the anode compartment and the diffusion products from the cathode compartment. The patent gives an illustration of the type of cell to be used. (1,195,617, Aug. 22, 1916.)

Fused Electrolysis Under Pressure.—A patent has been granted to ROBERT J. McNITT of Perth Amboy, N. J., for a method of reducing metals. The principle employed is to reduce the fused metallic compounds by means of electrolysis and to raise the boiling point of the metals to be extracted by means of pressure applied to the molten electrolyte either artificially or by the gases produced during the process. The temperature of the electrolyte must be kept below its boiling point at atmospheric pressure. An illustration of the type of cell to be used is given in the patent. (1,197,137, Sept. 5, 1916.)

Electrolytic Cell.—WILLIAM E. GREENAWALT of Denver, Col., has patented the electrolytic cell, shown in Fig. 1 in longitudinal section, in Fig. 2 in plan, and in Fig. 3 in transverse section. Fig. 4 is a detail section of the preferred construction and Fig. 5 is the corresponding plan. In the figures, 1 is a tank containing the electrolyte in which is suspended the electrode cell

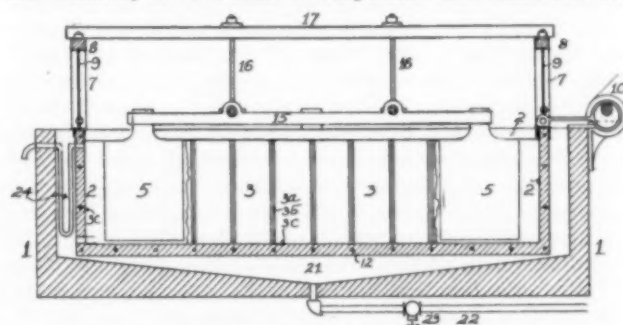


FIG. 1—ELECTROLYTIC CELL

2, by the flexible suspenders 9, from the beams 8, supported by the posts 7. The anode bell is oscillated by some mechanical means 10. The electrode bell is constructed by bolting diaphragms 3 to the pieces composing the sides of the cell 4. The diaphragms themselves are made of mullioned frames, between which is supported the diaphragm fabric; 5 represents the anodes, bolted together by the bar 15, which may act

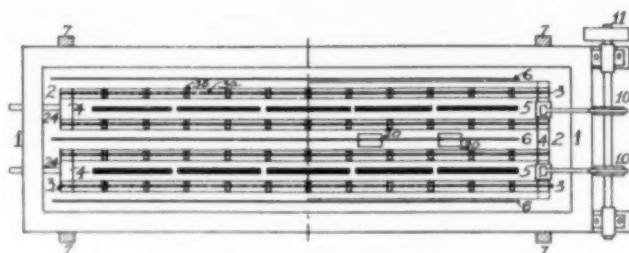


FIG. 2—ELECTROLYTIC CELL

as a conductor for the current. The anodes are suspended by the rods 16, from the beams 17. The cathodes are indicated by figures 6, and are suspended by rods 18 from the beams 19. The rate of oscillation will vary with the current density from 20 to 60 oscillations per minute. Openings 20 are placed in the bottom of the cathode compartment so that any non-adherent material may be worked through them by the oscillating cell into the bottom of the electrolyte tank 21, and then removed from time to time through the pipe 22 and valve 23. Similarly, the non-adherent anode material may be eliminated from that compartment by the oscillating electrode cell and the duct 24.

In the "preferred construction," both the anode and cathode compartments are bolted together and oscillate in the electrolytic tank. In this manner both the anolyte and the catholyte are thoroughly agitated and as the catholyte passes through the diaphragm into the anode compartment and is then exhausted by the duct 24 there is little chance for the ferric compounds, which usually are present in the electrolysis of copper solutions, getting back to the cathode and reducing the current efficiency, either through impoverishment of the electrolyte at the electrodes or by useless oxidation and reduction. In some electrolytic processes, as for example in the electrolysis of copper solutions with graphite or magnetite anodes, the diaphragm fabric may be omitted. The mechanical action of the apparatus is however maintained. In this case the fabric supporting frames, including the mullions or cross-pieces will act as agitators for the electrolyte, and this improves the electrolytic action. (1,186,898, June 13, 1916.)

Iron and Steel

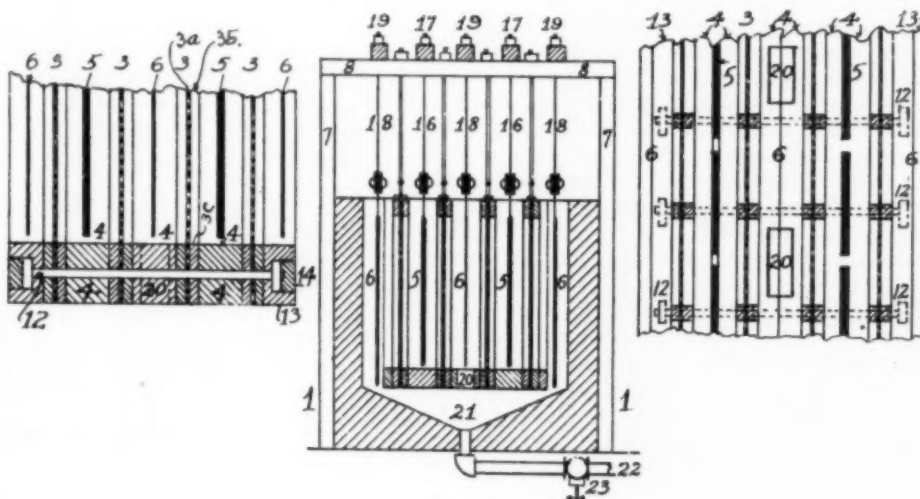
Untarnishable Iron Alloy.—An alloy which is useful for cutlery owing to its non-tarnishing properties is patented by HARRY BREARLY of Sheffield, England. It consists of iron containing between 9 and 16 per cent of chromium and less than 0.7 per cent of carbon. A typical composition is carbon 0.30 per cent, manganese 0.30 per cent, chromium 13.0 per cent and the balance iron. Small amounts up to 1 or 2 per cent of nickel, copper, cobalt, tungsten, molybdenum and vanadium appear to be without effect on the untarnishable properties. (1,197,256, Sept. 5, 1916.)

Soldering Composition.—A composition for soldering cast iron, mild steel, aluminium, etc., is patented by WILLIAM A. DAY of Bellingham, Washington. The

alloy consists of twenty-five parts lead, twenty-five parts tin and fifty parts zinc. The articles are prepared for soldering by cleaning and then covered with stearic acid or similar flux and the alloy is applied with an extra hot soldering copper. (1,195,955, Aug. 22, 1916.)

Electrolytic Process of Removing Rust.—An electrolytic process of removing rust or oxide from iron or steel in which the object to be treated is made the cathode in an electrolyte containing phosphoric acid, is patented by PASCAL MARINO, of London, England. The electrolyte is made up by adding ten parts of phosphoric acid to ninety parts of water or by adding 10 per cent of phosphoric acid to a 10 per cent solution of sodium phosphate. A temperature of 50 to 70 deg. C. is used. (1,195,704, Aug. 22, 1916.)

Steel and High-Phosphorus Slag.—A method of producing steel and high-phosphorus slag which can be used as a fertilizer is patented by ANSON W. ALLEN and EUGENE G. LILLY, of Birmingham, Ala. The method is an adaption of a process described in an application of



FIGS. 4, 3, 5—ELECTROLYTIC CELLS

William R. Walker, Oct. 7, 1914, No. 865,504. An example of the process as worked on Birmingham, Alabama, metal is as follows: The Birmingham pig iron running 0.8 to 1 per cent in phosphorus and about 0.8 per cent silicon is first blown in an acid Bessemer converter, the silicon helping to form a very fluid blown metal from which the slag can be thoroughly separated. The blowing is continued until the silicon is practically all removed and a large part of the carbon and manganese are also removed, leaving a high phosphorus blown metal. This is then separated as completely as possible from the slag and transferred to the second or roughing down furnaces.

The roughing down furnaces, as well as the finishing furnaces used are of the regenerative gas-fired open-hearth tilting type. The roughing down furnaces are basic lined for the removal of the bulk of the phosphorus from the blown metal to produce what is called duplex metal and the high phosphoric slag. The third furnaces are of the open-hearth regenerative gas-fired type, either tilting or stationary and either acid or basic lined according to the specifications of the steel to be made.

The roughing down furnaces are first charged with the necessary amount of lime and iron oxid to oxidize and carry into the slag the phosphorus contained in the blown metal. When a sufficient quantity of the blown metal has been charged and the slag is fluid and found to be of the right composition a measured quantity, say

mium is dissolved than the current can deposit, it is necessary to maintain the electrolyte acid.

The refined cadmium deposit is stripped from the copper cathodes, or, if cadmium cathodes were used, is melted directly under sodium hydroxide or paraffin and cast for marketing. The anode sludge contains quite a large amount of cadmium. It is therefore remelted, cast into anodes and again subjected to electrolysis. The sludge obtained from this second refining will be comparatively low in cadmium and high in copper, bismuth and lead.

To obtain the bismuth, the sludge from the second refining process is melted and cast into anodes, and electrolyzed in a bath containing bismuth sulphate, sulphuric acid and a soluble salt of sulphocyanic acid, preferably an alkaline sulphocyanate, together with sufficient glycerol to clarify the electrolyte. As cathode, copper is employed. Electrolysis is conducted at approximately 0.4 volts and 3 amperes per square foot. In this manner the bismuth is obtained in a pure state.

The patent describes the application of this process on bag house dust in detail, giving the chemical equations involved in the course of procedure. (1,194,433, Aug. 15, 1916.)

Mercury.—A patent has been granted to WILLIAM H. LANDERS, of New Almaden, Cal., for the apparatus shown in Fig. 7 for the recovery of mercury. A is a multiple-hearth furnace, the circulating air being received at 14; 20 is the flue through which the gases containing the mercury vapor leave the furnace and enter the dust-settling chamber B. This chamber has the double object of keeping the vapors sufficiently hot to prevent any precipitation or condensation of the mercury and to reduce the velocity of the gases entering it. The latter is accomplished by making its cross section large in respect to the opening at 21. Decreasing the velocity of the gases permits the settling out of the dust. The outlet passage 23, at the top of the dust-settling chamber, leads to the bottom of the condenser chamber C. This condenser chamber consists of a number of collecting chambers or trays 24, in a base 25 connected by a series of pipes 25. The last chamber connects with the stack. Between and around the pipes 25 are the baffles 27, which form the space for the circulating cooling air, which is supplied by a fan D. The fan as connected serves the double purpose of cooling medium and, due to the heat abstracted from the gases carrying the mercury, as an agent for increasing the velocity of the gases in the stack. The latter creates a suction through the whole system and thus serves to remove the gases formed in the furnace very effectively. In a separate illustration in the patent a device is shown, by which a final condensation of the mercury may be effected after passing the condenser chamber. (1,195,236, Aug. 22, 1916.)

Aluminium

Soldering Aluminium.—A soldering compound to be used in soldering articles of aluminium is patented by

FRANCIS E. J. LITOT, of Wilkesburg, Pa. The compound consists of 100 parts zinc and 1 to 10 parts phosphor tin. The smaller the proportion of phosphor tin present the greater will be its enduring qualities, but the higher its melting point. The best joints are made with 100 parts zinc to 1 part phosphor tin, which gives a sufficiently low melting point to prevent overheating of the aluminium. (1,194,648, Aug. 15, 1916.)

Composition for Welding and Soldering Aluminium.

—A low melting composition of metals for welding and soldering aluminium is patented by ROBERT L. WEATHERFORD, of Fort Worth, Texas. The composition consists of one part aluminium, one part lead, two parts tin, two parts zinc, one part bismuth and one part antimony. The ingredients are melted and thoroughly mixed by agitation, and treated five times with 66 per cent sulphuric acid. Two parts of acid to one of alloy are used, the function of the acid being to cleanse the alloy, just before being molded. After it has evaporated it leaves the dirt and sediment floating on the surface. The following instructions are given for use: "The article to be welded or soldered should first be freed from all dirt and obstacles by brushing the ends to be welded or the surface to be soldered with a steel brush. The parts so cleaned are then subjected to heat with an ordinary gasoline blow torch equal to about 800 deg., at which time the said compound is applied under the heat,

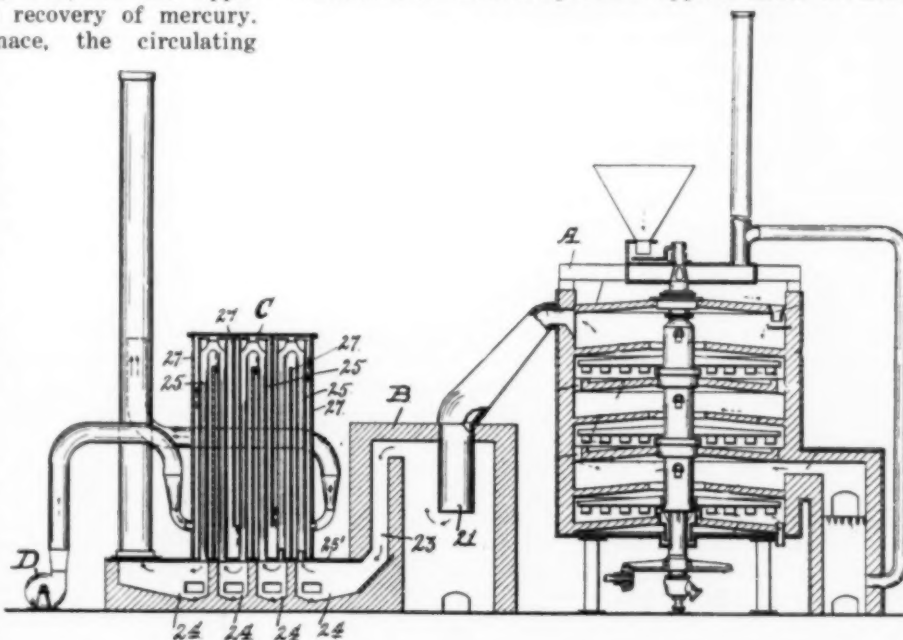


FIG. 7—APPARATUS FOR RECOVERING QUICKSILVER FROM ITS ORES

which causes it to become soft and doughy when it is worked into desired shape to correspond with the ends being welded, after which the work is allowed to cool and is ready for use." An advantage is claimed on account of the low heat used in comparison with the acetylene process which tends to weaken the aluminium through crystallization. (1,194,101, Aug. 8, 1916.)

Miscellaneous Processes

Hydrogen Peroxide.—A process for the manufacture of hydrogen peroxide is patented by FABRICIUS COBELLIS, of Philadelphia, Pa. The process consists in electrolyzing a solution of ammonium sulphate containing 3 lb. to the gallon to which is added 3 lb. of sulphuric acid (strength not given). A platinum anode and lead cathode is used, and the temperature kept below 60 deg. Fahr. The electrolysis produces a persulphate of ammonia and after a certain time the solution

is drawn off, placed in an autoclave, with the addition of 6 lb. of ammonium bisulphate per gallon, and subjected to a pressure of 100 lb. and a temperature of 280 deg. Fahr., when the hydrogen peroxide is formed. It is then cooled to 150 deg. Fahr. and a vacuum applied, the hydrogen peroxide now distilling over. Dry air or another inert gas is passed through the solution during the distillation. (1,195,560, Aug. 22, 1916.)

Process of Purifying Sewage.—An electrolytic sewage purification process in which the solids and liquid are first separated and then treated separately is described in a patent of DANIEL T. DOBYNS and JAMES K. ELDERKIN, JR., of Newark, N. J. The process consists in adding milk of lime to the raw sewage, agitating and allowing it to settle. The milk of lime precipitates the solids or sludge and the liquid is conveyed to an electrolyzer where it is oxidized by electrolysis. The separate solids are electrolyzed with the addition of sodium chloride solution in a separate electrolyzer. Sodium hypochlorite and oxygen are formed in electrolyzing the sludge and the purifying action of which is well known. (1,194,000, Aug. 8, 1916.)

Removing Drilling Tools from Oil and Gas Wells.—According to a patent of WALTER O. SNELLING of Pittsburgh, Pa., drilling tools which have become broken and jammed in drilling wells, may be removed by introducing a salt solution, lowering a copper bar until it makes contact with the iron drill and then passing a current of 300 to 400 amp. through the electrolyte. The nascent oxygen formed corrodes the iron, and this corrosion may be carried so far as to completely consume the tools, or only partial corrosion may be carried on, when the tools become dislodged and may be fished out. (1,196,819, Sept. 5, 1916.)

Electric Zinc Distilling Furnace.—An electric furnace and condenser for the distillation of impure metals which can be practically volatilized is patented by JOHN THOMSON, of New York City. The furnace is described in connection with zinc distillation. It consists of a trough to contain the bath of molten metal, a zig-zag resistor suspended horizontally above the trough, and a roof composed of spaced plates above the resistor. The fumes escape through these plates and they also serve to radiate most of the heat from the resistor downwards onto the bath. The construction of the resistor is one of the main features of the patent. It is made up of zig-zag plates in the manner originally proposed by F. A. J. FitzGerald ("Electrochemical and Metallurgical Industry," 1905, page 215). A carbon bar or slab is cut partially through, alternately from one side and then from the other, producing a zig-zag circuit of limited cross sectional area. The condenser connected with the furnace consists of a series of baffle plates so arranged as to cause the fume to flow back and forth, while progressing constantly forward. The condensed metal forms a bath in the condenser over which the uncondensed fume flows. The condenser may be heated by resistors in order to keep the temperature above that at which dust forms. A dust condenser may be operated in conjunction with the furnace and liquid condenser, the dust condenser taking any surplus fume. (1,193,633, Aug. 8, 1916.)

Nitrogen Products

Production of Oxamid.—A process for the production of oxamid (CONH_2), from cyanogen and hydrochloric acid is patented by JOHN E. BUCHER, of Coventry, R. I. (assigned to the Nitrogen Products Company, of Providence, R. I.). The object of the process is to produce oxamid to be commercially used as a fertilizer. It was announced by von Liebig in 1860 (Ann. 113, p. 246), that oxamid could be produced from cyanogen and aldehyde, and in 1867 by Schmitt and Glutz (Ber. 1, p. 66) that oxamid could be produced from cyanogen and hydrochloric acid, but nothing has been done since then to produce oxamid commercially. It is proposed in the present patent to conduct gaseous cyanogen liberated from a cyanogen compound, into concentrated hydrochloric acid, the temperature being maintained low enough to prevent the formation of oxalic acid. The hydrochloric acid acts catalytically to combine the water and cyanogen into oxamid. Water is added from time to time as it is used up. (1,194,354, Aug. 15, 1916.)

Rotary Pump

A rotary pump which is finding considerable use in handling the wash oil, tar, and ammoniacal liquor from by-product ovens owing to its positive delivery and ease of starting and stopping is shown in the following illustrations. The pump is a product of the P. H. & F. M. Roots Company of Connersville, Ind., manufacturers of pumps and blowers.

The operating principle of the Roots' rotary pump is very simple. The moving parts consist of two parallel shafts with an impeller on each and each having a gear keyed on the end. They are assembled at 90 deg. one to the other, and this relation is permanently maintained by means of the previously mentioned gears. Fig. 2 shows a view of the pump with the head plate removed, and Fig. 1 shows an assembled view. The impellers rotate in opposite directions. The suction pipe water is inclosed between the impeller (as shown in vertical position) and the case so that for an instant there is a body of water which is not open to either the suc-

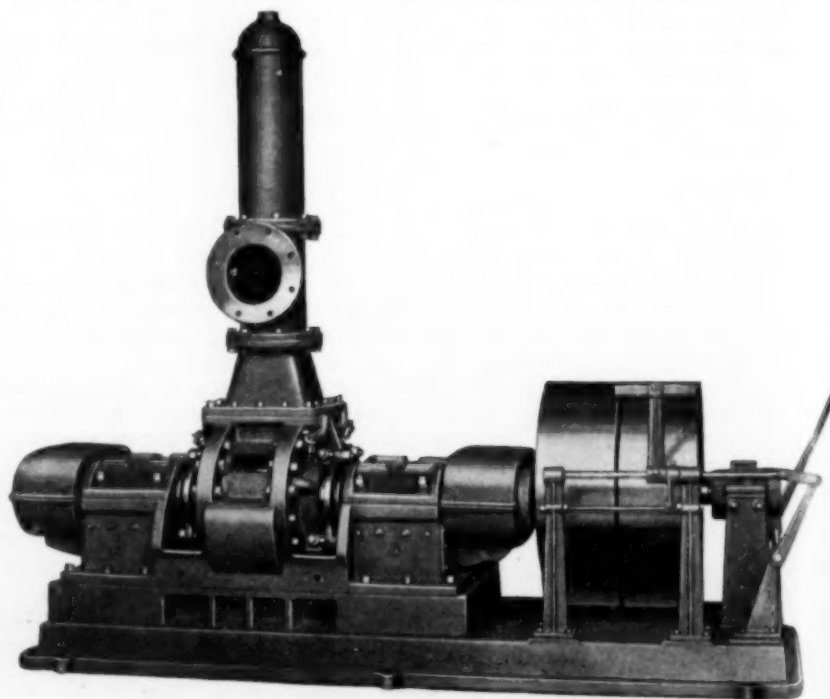


FIG. 1—VIEW OF ASSEMBLED PUMP AND DRIVE

tion or discharge sides. As the impeller continues to rotate, it immediately opens to the discharge side, and the volume which was inclosed is forced into the discharge side. Since, owing to the shape of the impellers, there is at no time a possible return between the shafts, it is evident that a quantity of water equal to the inclosed volume is discharged at every half revolution of each impeller. For each revolution of the pump, therefore, four times this volume is discharged.

The impellers are of steel, forged integral with the shaft. This design gives great rigidity, obviating vibrations, so harmful to

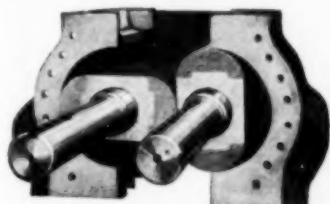


FIG. 1—PUMP WITH HEAD PLATE REMOVED

gears, stuffing boxes and bearings, and eliminates a pressed and keyed fit between the impeller and the shaft. The removable cast-iron tips may be changed without dismantling the machine. The case is composed of two identical semi-

circular castings and two identical headplates, all ribbed to eliminate deflection. They are of homogeneous, close-grained gray cast iron. Suction air chambers are cast in the lower part of the case.

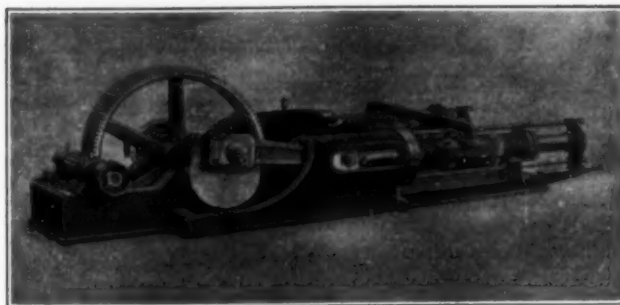
The bearings are approximately three times the diameter of the shaft which, since the shaft is of ample proportions, gives a very low bearing pressure. This together with profuse oiling maintained by oil chains or rings reduces wear to a minimum. Since practically all of the wear occurs vertically the single wedge beneath the lower half box permits adjustment at any time, if necessary, while the pump is in operation. In the pumps of large capacity the expense of a quarter box bearing is justified, owing to the greater nicety of adjustment thus made possible and which becomes necessary on the larger sizes. The main bearings are cast integral with the headplates, and the pump is self-contained on a deep well ribbed bedplate.

As these machines have their most common application for pumping water and non-corrosive liquids, cast iron and steel are commonly used, as previously described. In case the liquid to be handled is corrosive, suitable resisting metal is selected. Designs have been made for three ranges of pressures: low-lift pumps for heads from 0 to 30 ft.; medium-lift pumps or heads from 30 to 80 ft., and high-lift pumps for heads from 80 to 200 ft. Capacities vary from a displacement of one-tenth of a gallon per revolution up to 50,000 gal. per minute.

A Motor-Driven Four Plunger Horizontal Hydraulic Pump

The hydraulic pump illustrated by the accompanying photograph is a recent addition to the high-pressure hydraulic pumps built by The Hydraulic Press Manufacturing Company, Mount Gilead, Ohio. It is of the horizontal, four-plunger type and designed to fill the requirements for a simple, heavy-duty hydraulic pump for applying a large volume of water or other fluid against a high pressure.

The pump is designed so that it may be equipped with sixteen different sizes of plungers ranging from 1½ in. to 5 in in diameter, advancing by quarter inches. The water cylinders are made of forged steel for the highest pressures. For the medium pressures, 1500 to 2900 lb. per square inch inclusive, cast steel is used, and for the lowest pressures the cylinders are semi-steel. The pressures range from 9500 to 700 lb.



CLASS "O" FOUR-PLUNGER HORIZONTAL HYDRAULIC PUMP

per square inch, and the water capacity from 24 to 326 gal. per minute. All sizes have bronze valve seats and bronze or nickel steel valves. The pump is built for motor drive and requires 150 hp. to operate. It is equipped with a flexible shaft coupling for motor connection. Any 150 hp. motor having a speed of from 450 r.p.m. to 750 r.p.m. may be used. The speed of the crank shaft is 60 r.p.m., and the stroke of the plungers is 16 in., the two cranks being set at 90 deg., so that a uniform flow of fluid may be obtained.

The pump was designed so as to be especially adapted to long service. At all points where the strain and wear is most severe, the parts such as main bearings, connecting rod ends, cross head guides, valves and valve seats, are of easy access for adjustment and replacement. The frame or pump bed consists of two heavy castings bolted together. The cross head guides and main bearing containers are machined in this frame. The pump occupies a floor space 18 ft., 8 in. in length by 6 ft. 10 in. in width. The illustration shows the pump equipped with a spur gear and pinion, but it may also be equipped with a herringbone gear and pinion.

The Empire Concentrating Table

In the field of coarse concentration with high capacity, it is essential, if a table concentrator be used, that the stroke of the table be long and that the flow of the water over the table be such, as to prevent banking of the sands. These two features, it is claimed, are embodied in the Empire concentrating table, shown in Fig. 1.

While this table treats material ranging from ¼ in. to zero, its main field of application lies in treating the coarser material. The length and number of strokes depend on the size of the material treated, the strokes varying from 110 to 135 per minute, and the range of the length lying between 3 to 6 in. The head-motion is simple, eccentrically driven and positive in motion. The riffles are in channel form, made of a non-corrosive metal. The channel riffle gives an additional saving in the fine material within the riffle itself, which is not the case with the ordinary solid type of riffle.

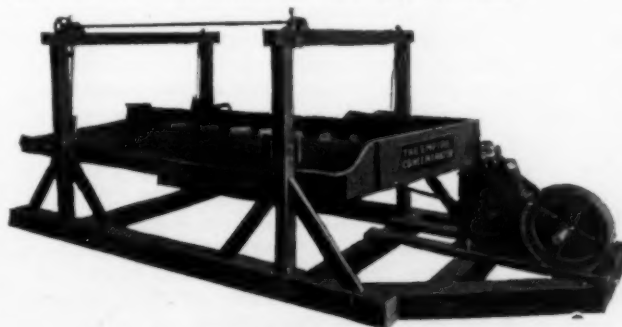


FIG. 1—THE EMPIRE CONCENTRATOR TABLE

If, on an ordinary Wilfley table, $\frac{1}{4}$ -in. material were treated the sands would bank along one line, due to the method of irrigating this type of table. In the Empire table a series of adjustable deflectors are employed, which give a peculiarly retained current to the wash water. This action makes it possible to use a long stroke with a large capacity. The length of stroke may be changed during operation by means of a hand-wheel, located at the head-motion. The tilting of the deck is regulated by a similar wheel at the discharge end of the table.

The deck is suspended in such a manner as to raise it vertically for a short distance on the forward stroke. The mechanism used in giving the table-motion produces a retarding effect at the end of the forward stroke and an accelerated effect at the beginning of the return stroke. The combination of the effects mentioned, together with the dropping away of the deck from the ore-bed on the return stroke, result in a jigging and panning motion. It is thus seen, that jigging in a separate machine may be eliminated with the use of this table.

The space occupied by a table is 5 ft. 2 in. by 12 ft. 7 in. The capacity per table is 35 to 50 tons of 30-mesh material per day and larger tonnage with coarser material. The water consumed per table varies from 10 to 12 gal. per minute. The power required per table is $\frac{1}{4}$ to $\frac{1}{2}$ hp. The table ready for shipment weighs 1300 lb.

Some of the advantages claimed for the table are: large capacity, clean concentrates, clean separation of the various minerals, clean tailings, replacement of the jig, small floor space occupied, simplicity of construction and manipulation, low power and water consumption and low costs of installation and operation. The table has been in successful operation in the Idaho Springs District, Colorado, and is built by The Empire Concentrator Company of Denver, Colo.

Modified Assay Furnace

In the accompanying illustration, Fig. 1, is shown a Bosworth assay furnace so altered that it will burn anthracite coal instead of coke, thereby reducing fuel consumption. The alterations have also resulted in increasing the capacity and facilitating repairs.

The ash-pit of the standard Bosworth has been replaced by a brick one of considerably larger dimensions, with a grate at the top to support the fuel, and with an iron ash-door in front of convenient size. Below the ash-pit was placed a $\frac{1}{2}$ -in. iron plate, projecting 18 in. in front. This plate makes a safe bed for the ashes to fall upon, and the projecting shelf a convenient and fire-proof place for slag molds and hot crucibles. The whole furnace may be safely supported on brick piers, as shown, or heavy pieces of timber. The piers are built up to such a height as to elevate the muffle to a position convenient for charging and uncharging. The compartment containing the draft-door has been left unchanged. The capacity of the furnace was increased by chipping out the muffle arch and replacing the standard-sized muffle with a larger one. Two muffle supports have been built into the rear of the furnace, replacing the one usually supplied, and so increasing the life of the muffle. Using a larger muffle leaves a space of only 2 or 3 in. between the muffle and the inside furnace walls, but this is sufficient for the anthracite fuel used. The hole in the top of the furnace has been enlarged, giving a better draft, and over this hole a permanent brick chimney was built. The entire weight of this chimney is supported by rods from the ceiling. This adds to the life of the furnace and facilitates furnace repairs,

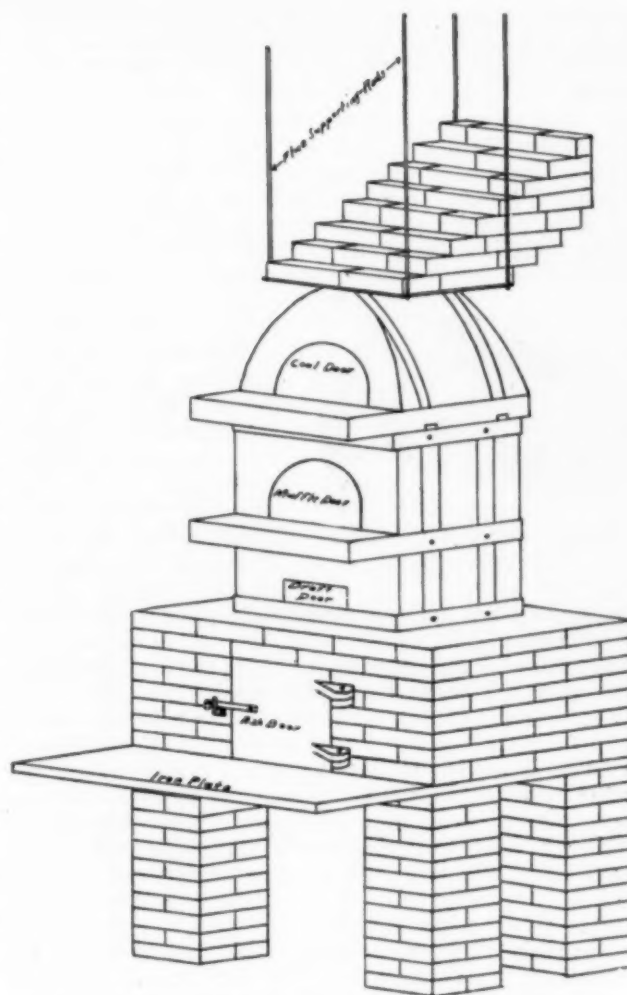


FIG. 1—IMPROVED ASSAY FURNACE FOR ANTHRACITE COAL.
SCALE 1 IN. = 1 FT.

as the entire furnace may be removed without disturbing the chimney. The joint between the chimney and furnace is simply luted with fire clay.

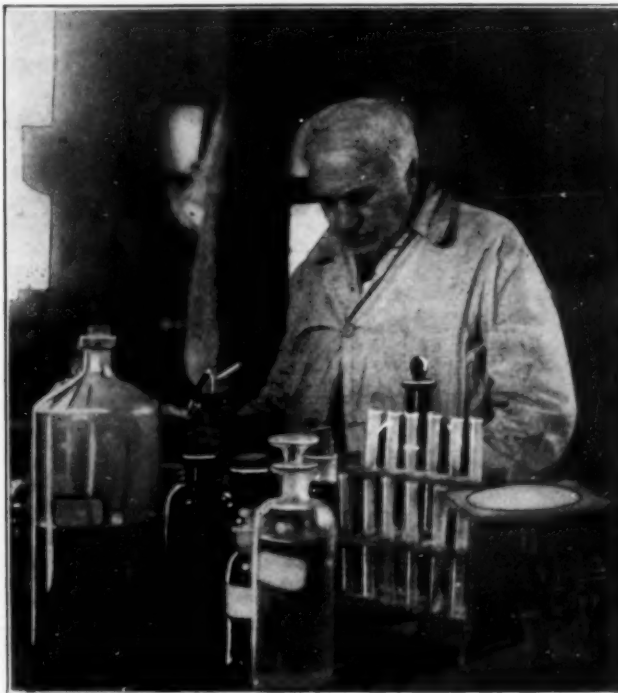
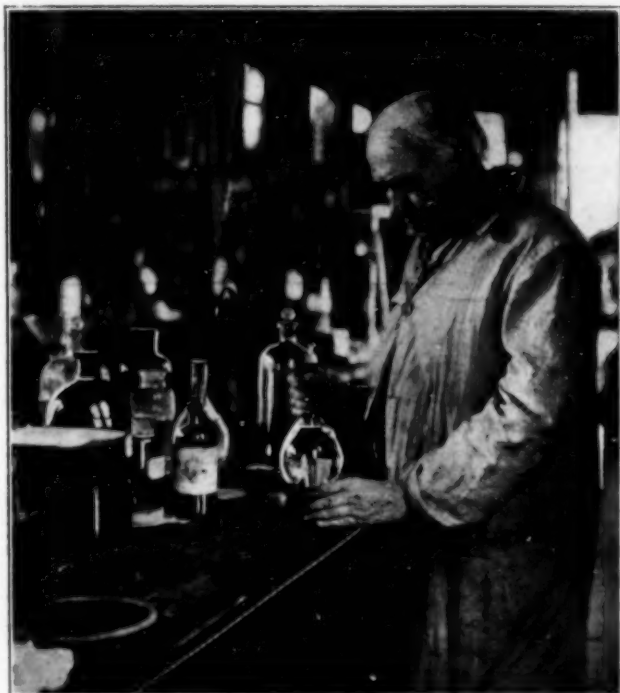
In starting the furnace, kindling and one bucket of coal are used. When this coal is well fired a second bucket is added, and by the time the whole mass is red, the furnace has attained a high heat, which it will hold for some hours, giving sufficient time for the fusion of a number of charges. This furnace is especially adapted to the needs of a custom assayer whose daily runs fluctuate considerably.

The above furnace has been designed by J. E. Dollison, of Alma, Colo., and is used by him in his custom assay office at that place.

Book Review

Canadian Trade Index. Issue of 1916-1918, 560 pages. Price, \$5.00 net. Toronto, Canada: The Canadian Manufacturers' Association.

This book corresponds to our directories of manufacturers and aims to provide buyers of Canadian manufactured goods with a dependable list of the articles made in Canada and the names of the manufacturers. Canada is growing, as evidenced by the fact that between 2000 and 3000 new names have been added since the last edition. The book is nicely arranged and contains both an English and French index of articles, together with an alphabetical list of manufacturers for ready reference.



TWO RECENT PHOTOGRAPHS OF THOMAS A. EDISON IN HIS CHEMICAL LABORATORY

Personal

Mr. George A. Burrell, at present consulting chemical engineer and president of the Natural Gas Products Company of Pittsburgh, Pa., was in Louisiana this month making tests of natural gas for gasoline content with the view of installing absorption plants. The Natural Gas Products Company uses an absorption process, worked out by Mr. Burrell, who was formerly in charge of natural gas, gasoline, gas investigations, and other research work for the Bureau of Mines. He was tendered a testimonial banquet and presented with a gold watch on Oct. 17 by his colleagues upon the occasion of his resignation from the Bureau of Mines.

Mr. T. C. Desollars, chief engineer of the Quincy Mining Co., Hancock, Mich., attended the American Mining Congress in Chicago.

Dr. Wm. F. Hillebrand, chief chemist of the Bureau of Standards, Washington, D. C., will lecture in Room 309, Havemeyer Hall, on Monday, Nov. 27, 1916, at 4.10 P. M., on "Analytical Chemistry and Its Possible Future." The lecture is one of the Chandler lecture series.

Mr. J. R. Holcomb has been appointed superintendent of the Wilmington Steel Company, succeeding W. J. Stoop, who has resigned.

Mr. Frederick W. Kressmann has severed his connection with the Forest Products Laboratory, Madison, Wis., to become manager of the plant at Fullerton, La., producing ethyl alcohol from wood waste. The plant was originally built by the Standard Alcohol Company and is at present being operated by the Standard Lessee Corporation.

Mr. Thomas Le Clear has resigned as chief chemist of Fraser & Co., of the Chemists Club Building, 50 East Forty-first Street, New York, and is now chief chemist with Marden, Orth & Hastings at Newark, N. J.

Mr. Clarence W. Marsh announces that he has established a New York office at 101 Park Avenue in order to make more available his executive experience in engineering investigations, plant design and construc-

tion for industrial, chemical and electrochemical enterprises.

Mr. Richard K. Meade, chemical, mechanical and industrial engineer, Law building, Baltimore, Md., has been retained by the Hercules Cement Corp. as consulting engineer in connection with the completion and improvement of the plant of the Atlantic Cement Co. at Stockertown, which they have purchased.

Mr. W. E. Mitchell is in charge of the residue-treating plant of the Anaconda Copper Co. at Great Falls.

Mr. William Motherwell, flotation engineer, has left Nelson, B. C., and will be located at Baker, Ore.

Mr. Louis Ruthenberg will be the new general superintendent of the Dayton Engineering Laboratories succeeding W. P. Anderson, resigned.

Professor William Kent Shepard presented a paper on "Physical Tests of Metals" at a meeting of the New Haven Section of the American Society of Mechanical Engineers, held at Sheffield Scientific School, Yale University, Nov. 15. Prof. C. H. Mathewson read a paper on "Applied Metallography."

Mr. Ambrose Swasey, president of Warner & Swasey Company, Cleveland, Ohio, and Dr. John A. Brashear, president of the American Society of Mechanical Engineers, will take an extended trip through Chile.

Dr. Jokichi Takamine and Dr. Alcan Hirsch sailed for Japan on November 23 to aid the Japanese government in building up a dye industry. A dinner in their honor was given on Saturday, Nov. 18, at the Waldorf-Astoria by J. P. Devine of the Buffalo Machinery firm of the same name.

Mr. W. Lee Tanner is chief chemist at the explosive plant of the Bethlehem Steel Co. at New Castle, Del.

Mr. Maurice R. Thompson, formerly superintendent of the electrolytic department of the Chile Exploration Company in Chile, is now with the General Electric Co., as electrometallurgical engineer. His present address is Schenectady, N. Y., but he will shortly go to Salt Lake City.

Mr. W. D. Thornton has succeeded Thomas F. Cole as president of the Greene-Cananea Copper Co.

INDUSTRIAL

Financial and Construction News

Financial

The Aetna Silk Company, Paterson, N. J., has been incorporated with a capital of \$10,000 to deal in silk, wool, etc. Incorporators are Simon Pansy, Solomon Friedman, A. Pansy.

American Chemical Specialty Company, Bridgeport, Conn., has increased its capital from \$10,000 to \$15,000.

The American Color Mfg. Company, Passaic, N. J., has been incorporated with a capital of \$100,000, to manufacture and deal in chemicals, drugs, etc. Incorporators are A. B. Sinclair, C. G. Francis, E. H. Killeffer.

The American Germicide Corporation has been incorporated with a capital of \$10,000. Incorporators are E. Whiteside, A. F. Barnes, H. R. Shores, 135 West Forty-seventh Street.

The American Paint Products Company, Chicago, Ill., has been incorporated with a capital of \$100,000 to manufacture paints and paint supplies. The incorporators are L. L. Cowan, H. F. Cowan, R. Montgomery, Chicago.

The Atlantic Dyestuff Company, Boston, Mass., has been incorporated with a capital of \$50,000. Incorporators are M. Reed, T. W. Nelson, T. W. Nason.

The Atlantic Oil & Refining Company, Dover, Del., has been incorporated with a capital of \$1,000,000 to acquire oil lands. Incorporators are N. P. Coffin, C. M. Enger, H. E. Latter.

The Augusta Refining Company, Tulsa, Okla., has been incorporated with a capital of \$750,000. The main office will be in Tulsa.

The Belleville Commercial Foundry, Belleville, Ill., has been incorporated with a capital of \$2,400. Incorporators are F. Rhein, A. F. Weichert, A. Zennert.

Boals Rolls Mfg. Company, Inc., New York City, has been incorporated with a capital of \$10,000, to manufacture medicines, chemicals and drugs, etc. Incorporators are J. R. Boal, and S. and M. Meyers, 302 Convent Avenue.

The Bowe-Burke Mining Company, Duluth, Minn., has been incorporated with a capital of \$50,000. Incorporators are W. W. Bowe, R. L. Burke, H. F. Erickson.

The Bridgeport Steel Company of Bridgeport, Conn., has been incorporated with a capital of \$100,000. The incorporators are C. R. Hall, J. F. L. Hubbard and M. K. Pedersen.

The Capitol File Company, Stratford, Conn., has been incorporated with a capital stock of \$50,000. The incorporators are Stephen Moskey, M. F. Moskey, Theo. E. Clark, Benj. J. Moskey.

The Caroune Oil & Gas Company, Pittsburgh, Pa., has been incorporated with a capital of \$1,000,000 to acquire oil and gas lands. Incorporators are J. E. Clark, Bellevue, Pa., J. K. Fawcett, Wilkinsburg, Pa., E. E. Bauer, Pittsburgh, Pa.

Climax Tube Company, Portland, Me., has been incorporated with a capital of \$50,000 to manufacture and deal in all kinds of paper and straw board. The incorporators are B. B. Sanderson, president; E. V. Mann, treasurer; Chas. D. Booth, M. F. Day, all of Portland.

Coldine Chemical Company, St. Louis, Mo., has been incorporated with a capital of \$50,000 to do a general chemical business.

The Continental Industrial Company, Inc., New York City, has been incorporated with a capital of \$5,000, to deal in chemicals, dyes, etc. The incorporators are M. Schneider, J. Ginsburgh, A. B. Stupel, 57 East Ninety-sixth Street.

Crescent Oil, Gas & Gasoline Company, Lexington, Ky., has been incorporated with a capital of \$60,000. Incorporators are J. A. Geary, W. J. Geary, L. L. Shadoin, B. D. Berry, K. D. Wilking.

The Dento-Chemical Company, Inc., New York City, has been incorporated with a capital of \$10,000. The incorporators are L. and S. Saens, D. Seigensohn, 201 West 120th Street.

Duristo Paint Company, Inc., Richmond, Va., has increased its capital of \$29,000 to \$99,000.

The Eagle Chemical Works, New York City, has been incorporated with a capital of \$10,000. Alexander Katz of Brooklyn is a director.

The Elfler Foundry Company, Imperial, Cal., has been incorporated with a capital of \$25,000, to convert the Elfler Machine Works into a foundry.

Elkland Tanning Company, Portland, Me., has been incorporated with a capital of \$100,000, to deal in all kinds of materials, including hides, skins, etc. Incorporators are G. L. King, A. E. Pierce, C. L. Donahue.

The Eureka Chemical Company, Inc., Wilmington, Del., has been incorporated with a capital of \$100,000.

The Friars Chemical Company, Wilmington, Del., has been incorporated with a capital stock of \$500,000, to carry on business of chemists, etc. The incorporators are G. E. Fooks, K. M. Dougherty, L. S. Dorsey, all of Wilmington.

The Guarantee Refining Company, Wilmington, Del., has been incorporated with a capital of \$500,000, to acquire and develop mineral lands. The incorporators are F. D. Buck, M. L. Harty, K. E. Longfield, all of Wilmington.

The Ideal Cyaniding Company, Davenport, Iowa, has been incorporated with a capital of \$25,075. Incorporators are A. E. Steffen, A. F. Tanner, A. G. Frick, O. Hill, A. G. Bush. The company will erect a large factory in Arizona or New Mexico.

The Independence Aniline & Refining Company, Independence, Mo., has been incorporated with a capital of \$1,000,000, to manufacture aniline dyes and by-products. The incorporators are A. F. Fonda, Dr. Paul Von Seidenorfer, F. G. Ward, F. C. Adams, I. A. Smith, E. E. Phillips, Z. R. Gurley. Headquarters are in the Martain Building in Independence.

The Interlake Pulp & Paper Company, Appleton, Wis., has been sold to the Consolidated Water Power & Paper Company of Grand Rapids, Wis., for over \$1,000,000. It will be run as a separate organization under the same local management.

McKenna Brothers Sales Corp., New York City, has been incorporated with a capital of \$5,000 to deal in glassware, china, etc. The incorporators are W. J. and T. McKenna, W. L. O'Connell, 281 Edgecombe Avenue.

Massy Bottom Mining Company, Pikeville, has been incorporated with a capital of \$6,000. Incorporators are I. J. Christie, M. C. Justice, A. J. Yonce.

Miami Zinc Company, St. Louis, has been incorporated with a capital of \$25,000. Incorporators are E. S. Gatch, B. Burnes, J. M. Blayne, Jr., N. B. Hatch.

The National Sulphur Company, Wilmington, Del., has been incorporated with a capital of \$1,500,000 to mine and extract sulphur. The incorporators are H. E. Latter, N. P. Coffin, C. M. Egner.

The National Type Foundry, Inc., Bridgeport, Conn., has been incorporated with a capital of \$10,000. The incorporators are Geo. S. Platt, Ed. E. Atkins, Wm. J. Platt.

Nats Creek Mining Company, Ashland, Ky., has been incorporated with a capital of \$32,000. Incorporators are L. S. Wilson, S. E. Harman, E. P. Rice.

The New England Drawn Steel Company, Mansfield, Mass., has been incorporated with a capital of \$210,000. Incorporators are W. B. McKinnon, Wm. McCarthy, and others.

The New Haven Malleable Iron Company, New Haven, Conn., has been incorporated with a capital of \$50,000. Incorporators are C. M. Brennan, E. F. Brennan.

The Nicolet Mining Company, Wilmington, Del., has been incorporated with a capital of \$1,000,000 to carry on mining and milling business of ores, metals, etc. Incorporators are F. D. Buck, G. W. Dillman, M. L. Harty.

The Ohio-Utah Copper Company, Inc., New York, has been incorporated with a capital of \$10,000 to mine, mill and concentrate gold and silver, etc. The incorporators are T. Adams, J. L. Frieder, F. Bien, Jr., 5 Beekman Street.

The Ohio Utilities Company, Wilmington, Del., has been incorporated with a capital of \$5,000,000 to manufacture artificial gas.

The Perfection Chemical & Mfg. Company, Cleveland, Ohio, has been incorporated with a capital of \$15,000. The incorporators are C. A. Black, C. A. Snyder, A. S. Schneider, W. G. Peterhamel, C. H. Felton.

Pure Gasoline Company, Wilmington, Del., has been incorporated with a capital of \$150,000 to acquire and develop oil and gas lands. Incorporators are W. F. O'Keefe, Geo. G. Steigler, E. E. Wright, all of Wilmington.

The Quaker City Drop Forge Company, Camden, N. J., has been incorporated with a capital of \$150,000. Incorporators are A. J. Glenner, L. Marsh, W. L. Layne.

The Reade Manufacturing Company, 1023 Grand Street, Hoboken, N. J., has been incorporated with a capital of \$20,000 to deal in chemical preparations and medicines. The incorporators are W. J. Reade, J. E. and Chas. H. Reade.

The Republic Oil Company, Wilmington, Del., has been incorporated with a capital of \$3,000,000 to acquire lands containing oil, gas and minerals. Incorporators are G. C. Steigler, W. F. O'Keefe, E. E. Wright.

Construction and Operation

Alabama

BIRMINGHAM.—The Semet-Solvay Company, the Alabama Company and Eastern capitalists are involved in proposed gigantic developments in this district. The Semet-Solvay Company, is reported to have purchased 7000 acres of coal lands from the Alabama Company and has acquired iron ore lands in Shades Valley and Irondale. Whether the developments will be carried out by the above companies or a new company formed is not certain. It is proposed to build a steel plant, several blast furnaces, by-product coke ovens, benzol and other plants. The Semet-Solvay Company has an annual coke production of 1,000,000 tons, and it is proposed to increase this to 1,500,000 tons. The company is capitalized at \$10,000,000.

Arkansas

FORT SMITH.—Charles T. Orr, of Webb City, Mo., will erect a \$200,000 smelter at South Fort Smith. The United Iron Works of Joplin has the construction contract.

California

GRASS VALLEY.—A large addition will be made to the cyanide plant at the Central shaft. The capacity will be doubled, on account of the consolidation of the North Star and Central Mills.

LOS ANGELES.—The Interstate Chemical Company, of Galveston, Tex., is contemplating the erection of a branch plant here to make "dynamine," a compound used in spraying for the eradication of pests. The branch plant will cost \$300,000, and will employ 150 to 200 men. I. F. Orton is vice-president of the company.

LOS ANGELES.—The Union Oil Company has taken options on several pieces of property near Wilmington, with the probable intention of erecting a refinery to take care of production in the Fullerton district. The company has a refinery in the northern end of the State, but the growth of production in the Fullerton district warrants one in this section.

MARTINEZ.—The Shell Oil Company will add four new distilling units to its large refinery, thereby greatly increasing the output of gasoline and refined oil.

PETALUMA.—The Encore Manufacturing Company will erect a branch paint factory here. The company has a plant in San Francisco. The contract has been let to Rodd & Rodd, of Petaluma.

PORTERVILLE.—The Magnesite Refractories Company, recently organized with \$200,000, will erect a large magnesite reduction plant. The factory will reduce crucibles for Eastern steel mills and manufacture brick and plasters. Charles B. Stetson, of San Francisco, heads the directors.

SAN FRANCISCO.—The Pacific Coast Glass Works has received a permit to build a 1-story steel factory addition to cost \$4,000.

SAN PEDRO.—Reported Union Oil Company, Union Oil Building, Los Angeles, Cal., intends erecting \$2,000,000 refining plant at San Pedro.

STOCKTON.—The Stockton glass factory will resume operations at its plant, under new ownership. The Patterson Glass Company are the new owners.

VALLEY SPRINGS.—The California Pottery Company is planning the erection of a paving brick plant at Valley Springs, in Calaveras County.

Connecticut

BRIDGEPORT.—George S. Youngs has purchased the old Dwyer sand bank on North Avenue and a large brass foundry will be located there.

District of Columbia

WASHINGTON.—Bids will be received at the Bureau of Supplies and Accounts, Navy Department, Washington D. C., for furnishing at the various navy yards and naval stations the following supplies: Portsmouth, N. H., Schedule 389—16 four-cycle gasoline engine. Newport, R. I., Schedule 384—for furnishing and installing two outfits for carrying away smoke and fumes; Schedule 382—miscellaneous annealed seamless copper tubing; Schedule 383—600 air pressure gauges; Schedule 390—two grinding machines. Washington, D. C., Schedule 381—one 5-hp. induction motor; Schedule 391—two grinding machines, one grinding machine (10 in. by 24 in.), one heavy milling machine, one universal milling machine, one high-power milling machine, three bench milling machines. Norfolk, Va., Schedule 388—2280 lb. phosphor bronze wire; Schedule 387—miscellaneous brass tubing, various diameter. Indian Head, Md., Schedule 381—one iron casting, single-stage centrifugal pump. Brooklyn, N. Y., Schedule 395—miscellaneous plunger pumps. Applications for proposal should designate the schedule desired by number.

Florida

JACKSONVILLE.—The Southern States Paint Mfg. Company, a new organization, will erect a plant here for making a preservative paint for vessel bottoms, etc. The company is capitalized at \$25,000.

JACKSONVILLE.—Wilson & Company, successors to S. Sulzberger's & Sons Company of Chicago, will erect a branch plant here to serve as a Florida distributing station. A refinery may also be erected in the near future. At the present time seven plants in different Southern cities are being erected by this concern, which is capitalized at \$60,000,000.

Georgia

ROME.—The old iron furnace here which has been closed for several years, has been leased by Chattanooga capitalists, and will be repaired and blown in. It is the only furnace in the section now idle.

Idaho

IDAHO FALLS.—The Western Potash Company contemplates the erection of a plant to extract potassium salts from sagebrush. Treatment of the sagebrush has been tried out in several places and promising results found. The plant will be used as a refinery and also for the burning of the brush from which the ashes are secured. A. Grimes is president, and M. A. Camp, vice-president of the company.

Iowa

CHARLES CITY.—The Hart-Parr Company has begun the erection of a steel foundry to cost \$100,000. Two 25-ton open-hearth furnaces will be installed.

Kansas

COFFEYVILLE.—The National Refining Company, an independent concern, will build a refinery here to cost \$250,000.

COFFEYVILLE.—The United Refining Company has announced that it will spend \$250,000 in remodeling its Coffeyville plant, to bring the capacity up to 250,000 barrels per month. The company is one of the largest independent oil companies and is capitalized at \$15,000,000.

INDEPENDENCE.—Plans are being prepared by Western States Portland Cement Company for rebuilding plant recently destroyed by fire; cost about \$100,000.

WICHITA.—The Kanita Refining Company has begun the erection of a \$500,000 refinery on the Santa Fe Railroad. The capacity will be 6000 barrels per day. E. C. Blasdel, of Pittsburgh, is superintendent.

Louisiana

BALDWIN.—The United States Sugar Company, a newly organized company, has purchased 1230 acres near Baldwin, and has options on 20 other plantations in Southern Louisiana. O. M. Nelson, formerly of the American Bank of New Haven, Conn., is interested in the company.

SHREVEPORT.—The National Glass Company, employing 200 men, is now operating forty-two shops, with a daily capacity of 8 carloads of window glass. Raymond Cornell is president. There is a big demand for window glass at present.

Maine

VAN BUREN.—The Arcoostook Pulp Company will erect a plant to cost \$500,000 to make sulphate or kraft pulp from the spruce waste wood from the saw mills.

Messrs. E. P. Lindsey, of Boston; George Lewis, of Holyoke, Mass., and E. M. Blaudin, of Bath, N. H., are interested. C. A. King, of Bangor, is chief engineer.

Maryland

BALTIMORE.—The Thomsen Chemical Corporation, manufacturer of sulphuric acid, has given bonuses to all its employees, ranging from 5 to 17½ per cent of their wages.

BALTIMORE.—A dinner was given to Charles M. Schwab by 300 of Baltimore's business men on Nov. 21. Mr. Schwab announced that the Bethlehem Steel Company would spend \$100,000,000 in additions at Bethlehem, Baltimore, Harrisburg and elsewhere. Between 15,000 and 20,000 men will ultimately be employed at Sparrows Point, at which place \$50,000,000 will be expended. Mr. Schwab predicted a large domestic demand after the war, which would more than offset the war demand.

CUMBERLAND.—The Wellington Glass Works has begun the erection of a \$20,000 addition to its plant, which will double its capacity. Automatic glass blowing machinery will be installed. Wright, Richardson & Company, of Cumberland, have the contract for the building. The company makes lamp shades, etc.

SPARROWS POINT.—A \$2,000,000 contract has been awarded to the Dravo Contracting Company by the Bethlehem Steel Company for extensions and improvements to the Sparrows Point plant. Four blast furnaces, a large open-hearth plant, a blooming and slabbing mill and two plate mills will be erected.

Massachusetts

GARDNER.—An effort is being made by local business men to start a paper mill here to cost \$125,000. A special committee, consisting of Chester Pearson, Harold E. Drake, Solon Wilder, Joseph P. Carney and Elmer W. Crouch, has been making investigations and raising subscriptions.

GARDNER.—Steps are being taken to incorporate the Gardner Paper Company, with a capital of \$200,000, for establishing a paper industry in Gardner. John P. O'Brien is one of the organizers.

MANSFIELD.—The Mansfield Foundry Company has secured the Rider Foundry property and will double its former capacity.

MANSFIELD.—The New England Drawn Steel Company has decided to locate its plant on High Street on the New Haven Railroad. The company will erect several buildings.

Michigan

DETROIT.—Reported that Henry Ford will build two steel mills to supply his factories with parts. No details are at present available.

PETOSKEY.—Work has been started to repair the damage done by fire to the mill of the Petoskey Paper Company, and operations will be resumed about Dec. 1. The paper-making part of the plant will not be rebuilt, but the pulp mill will be enlarged to double its capacity.

Minnesota

INTERNATIONAL FALLS.—The Minnesota & Ontario Power Company, a new corporation affiliated with the International Lumber Company of International Falls, Minn., has awarded to the Swenson Evaporator Company, of Chicago, a contract covering equipment of machinery for a sulphate pulp or kraft mill, to be erected at International Falls. This will be the largest mill of this type in America. Foundations are already in and construction is well under way. The mill is expected to be in operation by next spring or early summer.

Mississippi

HATTIESBURG.—The Hattiesburg Pulp & Paper Company has been organized to construct the paper plant here, announcement of which was given in our last issue. The company will make news print and construction will be commenced shortly. George R. Wright is at the head of the company. Charles W. Rantoul, of New York, is also interested.

Missouri

INDEPENDENCE.—The Independence Aniline Dye & Refining Company will occupy the K. I. drop forge plant in Independence and will make aniline dyes, paints, enamels, patent leather, varnishes, drugs, acids, roofing paper, etc. The estimated output is 30 tons per day. The company is working in a small way at present, but will need retorts, stills, boilers, evaporators, mixing vats, pumps, etc. Judge Anthony P. Fonda, of Kansas City, Mo., is president; Frank G. Ward is general manager; Wm. Meahl is superintendent and Prof. Paul Von Seiden-dorfer, chemist.

KANSAS CITY.—The Sinclair Oil Corporation will build a refinery here which will cover 100 acres, it was recently announced by Harry F. Sinclair, president. A car repair shop will also be built. The company has 2500 cars in service. The Sinclair company and the Cudahy Refining Company are associated in the undertaking. The Sinclair company is building an 800-mile pipe line from Oklahoma to Chicago and contemplates other large refineries to serve the Southwest.

ST. LOUIS.—The Central Iron Company will erect a modern shearing plant on North 16th Street. Louis Ladius is president.

Montana

ANACONDA.—The American Sugar Refining Company has been considering the erection of a beet sugar factory in the Deer Lodge Valley.

New Hampshire

PORTSMOUTH.—Reported that Albert L. Kraus, president of the Kraus-Millett Leather Company, has perfected a new solvent for use in the manufacture of pyroxillin products, to replace amyl acetate, which is mostly imported from Russia and Germany, and is now almost prohibitive in price. It is expected that the company will manufacture the substitute.

New Jersey

LINDEN.—Plans are reported to have been submitted to Township Building Inspector Albert Weber by a New York Company for a new dye factory.

NEWARK.—The Oxweld Acetylene Company has let contracts for three additional buildings at its plant at 646 Frelinghuysen Avenue. The buildings will cost \$14,500. Frederick Kilgus, Inc., has the general contract.

New York

BROOKLYN.—The F. W. DeVoe and C. T. Reynolds Company plan the erection of a \$100,000 paint factory at Smith, Huntington and Ninth streets.

BUFFALO.—The United States Alloys, Inc., has purchased a sixteen-acre tract adjoining a large site recently purchased by the Acheson Graphite Company. Both plants are near the new steam-electric plant of the Buffalo General Electric Company, between Buffalo and the Tonawandas. The new company will manufacture alloys used in steel manufacture.

DEPEW.—Albert Beebe & Company will build a \$70,000 silk mill here. The B. V. Taylor Company, of Olean, has the contract.

LONG ISLAND CITY.—The Manhattan Soap Company, of 426 West Thirty-eighth Street, Manhattan, has purchased a site on Hunter's Point Avenue, Long Island City, and plans the erection of a \$500,000 plant.

LYONS.—The Lyons Cold Storage Company plans the erection of an addition to its cold storage plant and the installation of ice-making machinery for making 30 tons of ice per day.

NEW YORK.—Werner & Pfleiderer Company, Saginaw, Mich., has taken new New York offices on the 37th floor of the Woolworth Building.

NIAGARA FALLS.—Additions are planned by the Hooker Electrochemical Company and the Carborundum Company.

PENN YAN.—Charles G. Moore, secretary of the Corrugated Container Company, of Buffalo, has purchased the Shotts paper mill and will make improvements.

RENSELAER.—The Bayer Company has commenced work on another addition to its plant. Plans are being prepared for more buildings.

WATERTOWN.—The Watertown General Utilities Company, Inc., a new company, has commenced the manufacture of a cleaning compound. The present capacity is 20 barrels per day. It is expected that this will be doubled by spring. The officers are John W. Hyde, president; Fred Chickering, treasurer, and Sidney K. Chickering, secretary.

WATERTOWN.—The Sawyer Products Company, of East Cambridge, has purchased the plant formerly occupied by the Bemis Rubber Company, in Watertown. Extensive improvements will be made and a new line of manufacture taken up.

Ohio

CINCINNATI.—Application has been made by the Charles Boldt Glass Company for a permit to build a \$50,000 paper mill at Red Bank and Eastern Avenues.

CLEVELAND.—The Adams-Bagnall Electric Company is now completing an addition to its factory with the installation of a complete vitreous or porcelain enameling plant. The company manufactures porcelain enameled reflectors for industrial lighting and will now have a completely equipped

plant for all the phases of manufacture. The enameling plant is being equipped for all classes of high-grade vitreous enameling. A battery of four 12-ft. furnaces will be supplemented with complete equipment of mixing vats, smelt furnaces, drying ovens and handling apparatus capable of producing a large output. The operation is in charge of men with thorough experience in vitreous porcelain enameling. The equipment is new and of the latest design to secure uniform results. As the complete outfit is new it has been possible to make a practical layout that permits most ready handling of the enameled products. In addition to enameling all aboites and associate equipment, the Adams-Bagnall plant will be capable of handling a considerable output of other vitreous enameling work. The plant will be in full operation before Jan. 1, 1917.

CLEVELAND.—The Artificial Silk Mills, a \$5,000,000 corporation, is building a plant at West Ninety-eighth Street and Big Four Railroad to manufacture artificial silk by a process brought over from Europe.

DOVER.—The Cleveland Steel Valve Company, capitalized at \$80,000, will erect a plant here.

MARIETTA.—The Pioneer Window Glass Company, a new corporation with \$80,000, has completed arrangements for the construction of a new glass plant in Westview.

MOUNT GILEAD.—To meet increasing business extensive plant and equipment improvements will be made by the Hydraulic Press Mfg. Company, Mount Gilead, Ohio. The improvements consist of one new building and extensions to the machine shop, power house, stock room, tool room and erecting shop buildings. To relieve the crowded condition of the machine shop an addition 100 ft. long by 60 ft. wide will be erected. Considerable new machine shop equipment will be needed for this addition, including a 20-ton electric traveling crane, a large motor-driven horizontal boring mill and a heavy duty motor-driven planer. A 20-ft. extension will be added to the present power plant building. New power plant equipment will be installed, consisting of a 300-hp. Corliss engine and a 225-kw. generator. Two new steam boilers and stokers for three boilers will be added to the present boiler equipment in the power house. A building for oil storage will be erected adjoining the new power plant building into which will be installed modern oil tanks with pumps as well as steam heating pumps, boiler feed pumps, etc. The main stock room will be extended and another story added. This will give additional space for the storage of small parts and accessories, such as hydraulic valves, fittings, packings, repair parts, etc. The tool room will also be extended to provide for new equipment and more storage space for tools, jigs, fixtures, etc. A new structural shop, about 50 ft. by 60 ft., will be erected. A new high-speed cut-off saw and traveling crane will be installed in this building. Space will also be provided for the installation of two modern sanitary closets with laboratory equipment. Individual lockers for the employees will be provided. The plans also include an extension of the present erecting shop building, measuring 47 ft. by 130 ft. For all of the building extensions brick and concrete construction with steel for the substructure work will be used. All of the above improvements except the last named will be made immediately.

SHARON.—The American Steel Foundries Company is erecting a large addition to its molding department. The plant is enjoying a period of great prosperity.

YOUNGSTOWN.—The Brier Hill Steel Company, upon completion of its 55 by-product coke ovens, will appropriate \$1,000,000 for 58 more ovens.

YOUNGSTOWN.—The construction of two new open hearths at the Brier Hill works is progressing rapidly and it is expected to have both smelters in operation by Jan. 1. When these furnaces are completed the Brier Hill company will have 12 in operation, producing about 60,000 tons of steel per month.

YOUNGSTOWN.—A large company capitalized at \$1,000,000, has secured an option on a site owned by the Concrete Sand & Stone Company, Jones & Brittain Streets. It is the intention to erect a plant for manufacturing acetylene and oxygen for welding purposes.

YOUNGSTOWN.—The Trumbull Steel Company has awarded contracts to the Wellman-Seaver-Morgan Company, of Cleveland, for four Hughes soaking pits and to the Alliance Machine Company, of Alliance, Ohio.

YOUNGSTOWN.—Structural steel has been purchased by the Youngstown Sheet & Tube Company for an extension to the soaking pit plant in the open hearth department. Rumors that millions would be

spent on extensions in the near future have been heard.

YOUNGSTOWN.—Youngstown Sheet & Tube Company, Stambaugh Building, contemplates improving plant extensively.

Oregon

KLAMATH FALLS.—A beet sugar factory will be established here if present tests on beet culture are successful.

PORTLAND.—The Northwest Steel Company may establish a rolling mill in connection with its shipbuilding plant in South Portland.

Pennsylvania

ALLENTOWN.—The Allen Chemical Company is erecting a phenol plant 40 by 130 ft., near Fifteenth Street, in Allentown.

CARNEGIE.—The Union Electric Steel Company of Pittsburgh, a \$350,000 corporation, has acquired a site of three acres in Carnegie on which to erect an electric steel plant. The Heroult furnace will be used. James D. O'Neil, formerly president of the United Coal Company, is president of the new company; H. O. Murphy is secretary-treasurer and W. J. Walker is superintendent.

DONORA.—The Fuller Engineering Company, of Allentown, Pa., are furnishing a complete pulverized coal plant and furnace equipment for eight 50-ton open-hearth furnaces for the American Steel & Wire Company.

FARRELL.—The American Sheet & Tinplate Company will erect ten additional hot plate mills at a cost of \$1,000,000.

FRANKLIN.—The Galena Signal Oil Company plans the erection of a \$100,000 refinery to produce motor oil.

HARRISBURG.—The Harrisburg Chemical & Paint Company will enlarge its plant on Hemlock Street. Application has been made to increase the capital from \$15,000 to \$100,000. William R. Reinick is president. Among the products of the company is a rust-proofing oil.

NEW CASTLE.—The American Sheet & Tinplate Company has appropriated \$1,000,000 for 10 new hot mills at its Shenango works, in addition to the appropriation for the Farrell works. The Shenango works is the largest of its kind in the world.

PHILADELPHIA.—S. B. & B. W. Fleischer will erect a six-story textile mill, together with a special bleachhouse and dyehouse. Both tub and machine dyeing will be done.

PHILADELPHIA.—The Belmont Packing & Rubber Company plans the erection of a plant in Philadelphia. The offices of the company are at 139 North Second Street, Philadelphia.

PITTSBURG.—The Carnegie Steel Company plans the construction of a sintering plant near Pittsburgh for the sintering of fine dust under a process just acquired.

REYNOLDSVILLE.—The Elk Tanning Company has received large leather orders from Russia and far eastern markets, and will make extensive additions to its plant in order to fill them. More than 6600 ft. of floor space will be added.

STRUTHERS.—The American Sintering Company is erecting a sintering plant near here to sinter fine dust from the Youngstown Sheet & Tube Company, Republic Iron & Steel Company, Struthers furnace and the Mary stack at Lowellville.

Tennessee

CHATTANOOGA.—Wilson & Company, the successors to S. Sulzbergers & Sons Company, the Chicago meat packers, will begin operations Dec. 1 at its new plant, one of the largest in Chattanooga. Over \$400,000 has been invested. Compound lard will be manufactured to supply all of Wilson & Company's distributing houses in the Southeast. Cottonseed oil will be refined.

Texas

BEAUMONT.—The Texas Steel Company, recently incorporated with \$2,500,000 capital, is erecting a plant which will have a daily capacity of 300 tons. The ore comes from East Texas and is a high-grade hematite, suitable for the modern open-hearth process. Beaumont is conveniently situated, coal being obtained by water from Alabama and limestone from Austin. The Alabama ores are lower grade and require more flux than these Texas ores.

HOUSTON.—The Stauffer Chemical Company of New York and San Francisco, will erect a large chemical and fertilizer manufacturing plant on the ship channel. A site has been secured adjoining the Magnolia Petroleum Company's plant at Manchester, now under construction. The Texas Portland Cement Company has a big plant in this section, operating 24 hours per day.

Utah

OGDEN.—The People's Sugar Company is building a plant at Maroni, Saupete County, in the midst of a tract of 20,000 acres suited for beet culture. George E. Browning, of Ogden, is head of the company.

MARYSVILLE.—Several buildings of the Mineral Products Corporation were partially destroyed by fire early in November. The oil house, compressor house, blacksmith shop, snow sheds and tramway head house were burned, entailing a loss of \$75,000. These will be rebuilt as soon as possible. The plant is operated by Armour & Company, and is valued at \$800,000.

PARK CITY.—The Broadwater Company will remodel its mill and install additional machinery and will then begin working a big acreage of tailings. Mr. W. H. Kurylan had charge of the sampling of the company's holdings.

The new electrolytic plant of the Judge Mining & Smelting Company is progressing nicely. From present indications the plant will be in operation early in the new year. Kurylan is general manager and Eric Neilson is construction superintendent.

SALT LAKE CITY.—The Utah Copper Company contemplates spending \$5,000,000 in enlarging its mills at Magna and Arthur, and at Garfield. This does not include the million dollar appropriation for enlarging the tailings pond.

The American Smelting & Refining Company will spend \$5,000,000 in enlarging and improving the Murray and Garfield plants, including new zinc smelting equipment.

Virginia

CHARLOTTESVILLE.—H. E. Young & Company will build a \$150,000 plant for manufacturing dye and extracts.

NORFOLK.—Fire destroyed several large buildings here on Saturday, Nov. 18, causing a loss of \$400,000. The Twin City Iron Works and the Norfolk Hide & Metal Company will erect new buildings to replace destroyed ones. The American Hide & Fur Company has secured temporary quarters pending the repair of another building owned by the company. The company had \$40,000 worth of hides, the damage to which is unestimated.

RICHMOND.—The American Locomotive Works is negotiating for property west of its Richmond branch, on which it is proposed to build an iron foundry.

RICHMOND.—The Dixie Paper & Pulp Company is negotiating for a site on which to erect a plant. The company was recently incorporated for \$50,000. Richard H. Smith, of the Planters' National Bank, is interested.

Washington

SPOKANE.—The Slocan Star Mines, Ltd., will operate its mill with a new hydroelectric power plant recently completed. The company produces zinc concentrates.

SPOKANE.—The United Gold Mining Company will shortly begin milling operations at the Cougar property. Cyanide, zinc boxes and zinc shavings recently reached the property from San Francisco. Algernon Del Mar is metallurgist and mill superintendent, and W. W. Robbins of Spokane is mine superintendent.

TACOMA.—Improvements are being made to the Tacoma smelter of the American Smelting & Refining Company, including the construction of a large flue from the furnaces to the concrete stack. Further enlargements to this plant are expected, and it is reported that a steamship line will be established to South America to bring copper ore here for smelting.

West Virginia

CLARKSBURG.—Glass factories are suffering from a shortage of freight cars for hauling sand. Officials of the Baltimore & Ohio Railroad have promised relief.

Wisconsin

MILWAUKEE.—The Wash-Rite Glove Company will erect a tanning plant to cost \$28,000, at North Pierce and Center Streets.

Canada

COCHRANE, ONT.—The Frederickhouse & Abithol Pulp Wood Company plans the erection of a new plant to cost \$150,000. J. A. McAndrews, Lumsden Building, Toronto, is in charge.

Hayti

PORT AU PRINCE.—The Haytian-American Corporation, controlled by American capital, will build one of the largest sugar refineries in the world in Hayti. A. J. Grief, formerly associated with the late E. H. Harriman, is president.